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MECHANICAL ENGINEERING

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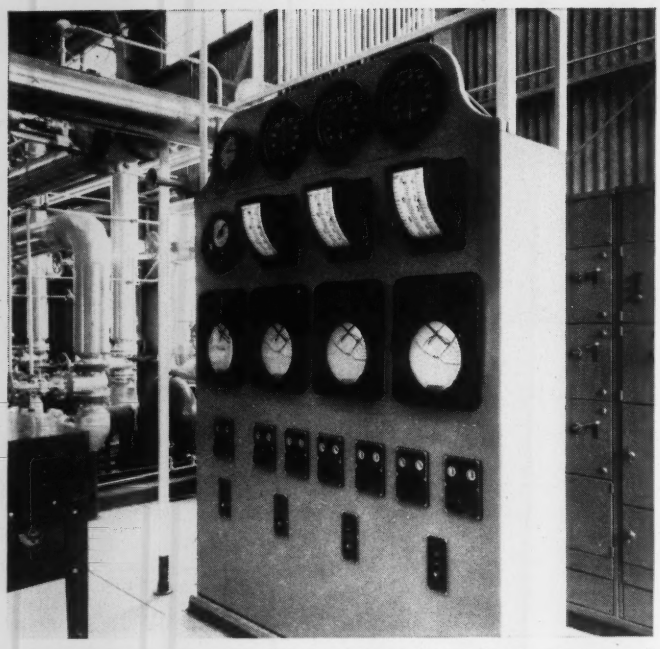

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Importance of Engineering Science
on the Future of the Profession[1]

By S. C. Hollister

Dean, College of Engineering, Cornell University, Ithaca, N. Y. Member ASME

The shortage of engineers has presented to us entirely new concepts concerning the engineering profession. It has caused us to examine more closely not only the preparation of the engineer for his profession, but also the availability of young men for such training. We have thus come upon the startling fact that, because of the limited number of young men of college age who have the necessary level of intelligence to accomplish a rigorous engineering course, the number available for training in engineering is limited. An even more important fact is that we have now reached the limit of qualified young men available for training in engineering in terms of percentage of population. Although there is immediately ahead of us an actual increase in the number of young men who will be available, the percentage in each age group available for training in engineering cannot increase. The conclusion must, therefore, be reached that within the pattern in which we utilize engineers in our society and within the pattern of training now in operation in this country, the shortage of engineers we are now experiencing is here to stay.

MANY who are in the field of applied mechanics and related subjects are in an excellent position to appraise the extent of the great expansion of utilization of engineers that our present and future society demands. If we look backward as well as forward, we are impressed with the fact that this demand for engineering service is continually accelerating. If we think, therefore, of the increasing service per hundred thousand of population and set next to it the fact that the number of engineers per hundred thousand of population has now reached the maximum of availability and thus is leveling off, we realize that something must be done about the widening gap between service need and manpower supply.

I have said that the shortage is here to stay provided two conditions now in vogue are continued, namely, the present pattern of utilization of engineers, and the pattern of preparation of the engineers. While there are admittedly other contributing factors to aid in sustaining the shortage, I believe these two factors to be the most important. I am convinced also that they are the ones to which we must address our attention and our energies if we are to improve the situation.

You who are in applied mechanics and related fields, it seems clear to me, are in a strategic position to evaluate the technical trends in engineering in all its phases. You are aware of the increasing application of mathematics and the basic physical sciences. You are also aware of the expanded activity in fields related to thermodynamics, fluid mechanics, electronics, and electromagnetism. Many of you are also aware of the nature of the development of nuclear engineering. Since your work is common to all of the engineering curricula, you are therefore able to evaluate the way in which strengthening in these subjects is permeating, or failing to permeate, subsequent courses in the curricula.

Undergraduate Mechanics Teaching

You will recall that thirty years ago a major number of our engineering colleges were teaching mechanics without the use of the calculus. In part this was due to the fact that a four-year curriculum has to be telescoped to a considerable extent in order to begin, as most schools do, with algebra and trigonometry, and, at the same time, end with anything like a useful point at the end of the fourth year. This telescoping forced many schools to teach mechanics at a time when the calculus was not fully available. At that time also, many people were experimenting with the curriculum, in the hope that something could be devised that would require only a minimum of technical competence and, at the same time, prepare a man for upper-level management in industry without the burden of a great deal of engineering education. These factors, when coupled, achieved a status of great weakness in the curricula of those days.

Into this situation came a new and stimulating leader in undergraduate mechanics teaching. Through his preparation of new textbooks in this field, Professor Timoshenko brought to the classroom the teaching prevalent on the Continent. He and his graduate students have had a profound effect upon mechanics and related fields in achieving a more advanced viewpoint and competence in our engineering schools. It was fortunate that the general advancement of this field took place well before our entry into the second world war.

The function of the engineer is to engineer something into existence. This may be done not only through analysis and synthesis using analytical tools, but it may also be done by trial and error, or with the use of models or analogs. It is not always necessary that the engineer arrive at precise accuracy because the extent of the function may vary considerably and the design may have

[1] Abridged from *Applied Mechanics Reviews*, May, 1955.

to be, in fact, an envelope of a lot of circumstances of function. The work of the engineer is sharply separated from the work of the scientist, who is seeking laws of behavior and who has reached his goal when he has determined such laws within the prescribed conditions.

In the training of engineers, the study of such subjects as mechanics, fluid mechanics, thermodynamics, and similar engineering sciences marks the departure from the field of science into the field of engineering. It is the beginning of the training for competence in analysis and synthesis. It is thus the beginning of true engineering.

The ability of an engineer is determined by his power of attack on design problems, together with the insight into behaviors of things that are not yet built, but which he has under contemplation. Thus the range and depth of his training will determine the power with which he may be able to attack a design situation. More particularly, it is to be noted that the engineer works on his problem when it is only a figment of the imagination. He must understand the concepts of possible actions so thoroughly that he may think of them with great ease. His resourcefulness will be measured by the facility with which he may be able to visualize accurately, and thus to anticipate possible difficulties. His analytical ability will be used largely to test quantitatively the function of the thing he is contemplating.

It is clear that in these terms good men in the field of mechanical or civil engineering, or in the apparatus side of chemical and electrical engineering, must have materials and their behavior under service conditions. Corrosion, biaxial and triaxial stress states, fatigue, vibration, corrosion under stress, behavior at advanced temperatures, and surface phenomena lie in the range of modern designing. The physicist is just beginning to give detailed attention to the solid state. The engineer has, for many years, been obliged to design under these conditions, often with considerable inadequacy. People in mechanics, however, are obliged to take cognizance of these factors and to assist in protecting the adequacy of design even though it may not be refined to the point which someday we may be able to achieve.

A competent person in mechanics is aware of the danger of overdesign, in the sense of providing excess material at a point where analysis is difficult. Redundancy, in mechanics, is just as much of a sin as weakness. It is of a special importance in situations involving fatigue, vibration, biaxial, triaxial stress, residual stress, and thermal problems.

People working in the field of mechanics, are, in my opinion, working in the range which defines the adequacy of the curriculum. They draw together, and give meaning to, the basic sciences. They set the stage for the exploration of engineering situations and courses to follow. It is their privilege and responsibility, therefore, to see to it that the degree of competence is achieved in analysis and synthesis, and that the stage is set for a high-level application of this competence to more extended engineering design in subsequent courses.

Machine-Design Courses Antiquated

My observations also indicate that the courses in machine design are pretty generally antiquated. There is more likelihood that modern design is met in mechanics and in the consideration of materials than in courses in machine design. It may be that those in mechanics will have to take over the work in machine design in order to bring it up to an adequate level. Already, in many schools, the work in mechanics is so good that the students are critical of their work in machine design and other courses that follow thereafter. This situation will force an evolution in the later courses of the curricula that is long overdue. It is a good illustration of the power that lies in the area of mechanics in the practice of engineering, and the extent to which this power may be applied to bring about more advanced considerations of engineering in the latter part of the curricula.

Cultural Subjects for Engineers

Another important contribution would be the interjection into engineering curricula of truly cultural values. In the first place, it should be a part of the teaching of mechanics and other applied-science courses to mention the great philosophers, scientists, and engineers whose discoveries opened up new possibilities for the development of our profession. Many of the greatest minds that ever lived have participated in making important contributions to the engineering sciences. This fact strengthens the concept that engineering is truly a learned profession. That it ranks with the field of philosophy in serious contemplation and that it is essentially an achievement of the intellect and not of materialism. To this end, every person in the applied sciences should have available for ready reference Wolf's great "History of Science, Technology and Philosophy," and should bring to the attention of his students the circumstances under which these great achievements came about and something of the personalities involved and the times in which they lived. They should be brought to the realization that they also are privileged to work in the fields which were so attractive to some of the greatest men of history.

I would also like to inject another word of caution at this point. The line between science and engineering is sometimes very hazy. Engineers who have taken advanced work in the sciences are often intrigued by the notion of giving themselves status through calling themselves scientists. Whether a man is a scientist or an engineer depends upon how he functions and not how he was trained. It is important also that one's teaching reflect this fact, and that the engineer be trained for his function which is engineering and not science.

Summary

In summary I call attention to the changing power of attack that is derived from the strengthening of that part of the engineering curricula dealing with the engineering sciences and which consists of a wider knowledge of physics and chemistry and the use of more advanced methods in mathematics. The further strengthening of the curriculum will come when these advances are continued into the subjects which follow in the curricula. I urge all in the engineering sciences to exert their influence to bring about a widening of scientific knowledge on the part of engineers; of strengthening of the analytical tools; and, through the maintenance of a broad approach, by the inclusion of many factors involved in each situation before the engineer, to encourage the exercise of broad judgment and the making of practical decisions.

The Complementary Role of Physics and Mechanics in Engineering Education

ASEE Conference examines current concepts of instruction and proposes new approach

By Glenn Murphy

Head, Department of Aeronautical Engineering, Iowa State College, Ames, Iowa. Member ASME

AMONG the many ideas being explored in the continual attempt to improve engineering education is that of eliminating unnecessary duplication of effort in allied departments. One possible area of duplication is that of mechanics as it is usually taught in the department of physics and later in one or more departments in engineering. To explore the teaching of mechanics, the National Science Foundation recently sponsored a conference[1] of about twenty of the leading educators in the field.

Evaluating Instruction Methods

In evaluating the instruction in mechanics as it has been and is given by physics departments, the group found that in the majority of schools the courses in physics are considered prerequisite to engineering mechanics. As a result the student is exposed to a barrage of ideas, concepts, principles, formulas, and solutions to problems at a rate well above that at which he can be expected to absorb them simply because so much material must be covered in so little time.

As the conference progressed it became clear that the function of the first course in physics in an engineering curriculum should not be that of serving as a prerequisite to mechanics and other engineering courses. Instead, the course should be directed toward giving the student an understanding of the concepts and principles that are basic in our physical world. Applications of the principles in the physics department should not be directed toward the solution of those engineering problems that must be considered later in detail in engineering mechanics. Rather, the applications should be directed in such a way that the student will develop confidence in his reasoning ability and his ability to arrive at correct conclusions when working with phenomena, the details of which are not directly apparent.

In considering solid-state physics as a part of the physics program, it was brought out that the engineers are interested in a course at the junior or senior level that will give the students some insight of the behavior of materials so that the development of courses in engineering materials can proceed along other than strictly empirical lines. It was conceded that classical solid-state physics is at the graduate level for physics majors.

Instruction in mathematics, as it related to the problem, was considered and led to the conclusion that the student should be introduced to the concepts and a working knowledge of calculus as early as practicable in his college curriculum. It is equally important that the mathematics then be used in the engineering courses.

Conference States Objectives

The discussions culminated in a statement which was adopted unanimously by the members of the conference. Excerpts from the statement follow:

The conference found, after a careful analysis of the statements of the objectives of undergraduate instruction in both physics and engineering, that the objectives are not competitive in scope but actually complementary when the courses are planned and taught properly.

It was concluded that there is an essential difference in the approaches to mechanics by the physicist and the engineer. There is a place and, indeed, a need for both of these approaches to the teaching of mechanics. The different objectives should continually be recognized and used as guides in planning courses.

Objectives of Physics Instruction in Mechanics. The primary objective of physics instruction in an engineering or scientific curriculum is to provide the student with an understanding of the physical principles that describe nature, of how these principles have evolved, and of their scope and limitations. Such an undertaking must begin with the study of Newtonian mechanics. Great emphasis should be placed on the conservation principles. The generalization of these principles along with associated concepts has formed the basis for modern physics, including such special branches as atomic and nuclear physics and the physics of the solid state.

With this approach, it is neither practical nor desirable in the physics course to devote attention to the development of facility in detailed application of physical laws to practical problems encountered in engineering practice. Stimulating problems should be selected with a view to illustrating physical principles, and it is essential that they be accompanied by a challenging laboratory experience.

In order that the study of Newtonian mechanics be effective in setting the stage for a proper understanding of the concepts and methods of modern physics, it must be recognized that a significant difference exists between the older physics and most of modern physics. In modern physics a large amount of theory is often inter-

[1] The conference was organized by the Physics Division of the American Society for Engineering Education under the guidance of Prof. F. L. Singer of the Engineering Mechanics Division of New York University, who also is current chairman of the Mechanics Division of ASEE.

Report of the Conference on Physics and Mechanics in Engineering Education held at Gould House, New York University, New York, N. Y., January 23–26, 1955, of the American Society for Engineering Education. Condensed slightly.

posed between observations and the conclusions based on them. Nevertheless, the pedagogical approach in which macroscopic observations are used directly as a guide in building theory must first be employed, as it can in mechanics; the student must later be led to the present-day methods of inferring conclusions regarding phenomena not directly observable. These methods are, in fact, used in kinetic theory, optics, and electricity, as well as in many topics of modern physics.

To achieve this goal, the role of conservation laws in mechanics and electricity can hardly be overemphasized. The study of mechanics also should include the dynamics of systems of particles, wave propagation, standing-wave systems, and so on. Valuable for later work in modern physics will be the study of resonant systems, such as the mechanical harmonic oscillator, accompanied by demonstrations or discussions of similar resonant systems in electricity, nuclear-magnetic resonance, and examples from acoustics and optics. It is in this spirit that instruction in mechanics makes a significant contribution toward the understanding of phenomena in atomic, nuclear, and solid-state physics.

Objectives of Instruction in Mechanics by the Engineer. The prime objective of instruction in engineering mechanics is to provide the student with a useful understanding of the methods and principles needed to design and predict the performance of real engineering systems and structures. The preparation of engineers for creative design should be kept always in mind. Creative design requires as much ingenuity, imagination, and resourcefulness in the application of physical laws and principles and in making them useful to man as is required in the original formulation of them.

In order to solve real problems of the great variety and number that are presented to the engineer, it is necessary that he become proficient in a systematic method of problem solution. Consequently, instruction in methodology is an essential part of engineering mechanics.

The engineer must devote major emphasis to the formulation and evaluation of his problem quite apart from the necessary analysis. Instruction given the engineering student should reflect this fact.

It is in this spirit that the instruction in engineering mechanics assumes a significant role as a springboard to a truly professional attitude and approach to all engineering situations.

Objectives of Instruction in Solid-State Physics. Before considering the place, if any, of solid-state and nuclear physics in engineering curricula, it is desirable to consider the activities of physicists in these respective fields. In nuclear physics the physicist is concerned with the quantitative behavior and structure of nuclei, the nature of forces involved between nuclear particles, and the interaction between nuclei and radiation. In solid-state physics the physicist is seeking to develop an understanding of the properties of solids on the basis of their atomic constitution.

To take part in the current activities in either of these fields requires a background and a working knowledge of quantum mechanics as well as of the general principles and conservation laws of classical mechanics and electrodynamics. Such knowledge can be obtained only through several years of study, generally including graduate work. The conference states its conviction that there is no short cut by which this knowledge can be given to undergraduate engineering students by means of a one or two-semester course in modern physics.

On the other hand, an introductory course of one or two-semesters' duration could be given following the general physics course. Such a course should broaden the training of the undergraduate engineer.

Mathematics Instruction as Related to Mechanics. It is urged that the concepts of calculus be introduced in engineering curricula as soon as possible, preferably in the freshman year, and used in physics and engineering as soon as feasible.

Conclusion. In comparing the different objectives and points of view of instruction in mechanics by physicists and engineers, it should be emphasized that the physicist uses problems and examples from experimental physics essentially for the purpose of developing by the inductive method those concepts and principles which it is his objective to have the student understand. The engineer, on the other hand, uses certain concepts and principles for the purpose of achieving the solution of practical engineering problems. This distinction should determine in a major way the essentially different character of illustrative material used in each area.

It is evident that the preservation of the two different but mutually supporting points of view of the physicist and the engineer is a necessary condition for maintaining the progressive program of engineering education, which in these critical days is of vital interest to the entire nation.

The conference recognizes that progress occurs through continuing experimentation and therefore recommends that such an attitude be encouraged in the teaching and the curricula arrangements of physics and engineering mechanics.

Implementing the Program

Throughout the conference there was the recurrent theme that the improvement of engineering education, which is of vital concern to all, can be achieved through the enthusiastic participation of individual staff members in co-ordinated local programs of evaluation and improvement of teaching of engineers. While a conference of the type held at the Gould House can indicate general patterns of improvement, the details which constitute the real benefits must be worked out at each school in harmony with the particular local situation. It is only through continual experimentation toward improvement at the individual institutions that over-all progress will be made.

The following participated in the conference:

Dean J. W. Buchta, University of Minnesota
Prof. J. W. Cell, North Carolina State College
Prof. P. F. Chenea, Purdue University
Prof. W. L. Collins, University of Illinois
Prof. J. P. Den Hartog, Massachusetts Institute of Technology
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Prof. I. S. Sokolnikoff, University of Calif. at Los Angeles
Prof. W. B. Stiles, University of Alabama
Prof. D. Williams, Ohio State

The Homogeneous Reactor Experiment

A Pilot-Model Nuclear Power Plant

By W. R. Gall

Oak Ridge National Laboratory,
Carbide and Carbon Chemicals Corporation. Member ASME

A nuclear pilot plant for the production of electric power with an aqueous solution of uranyl sulphate as fuel has been designed, constructed, and operated by the Oak Ridge National Laboratory over a four-year period. The heat-producing reaction occurred in an 18-in-diam spherical vessel and heat was removed by pumping the liquid fuel through a U-tube heat exchanger where steam was generated for use in a small turbogenerator unit. With the reactor generating 1000 kw of heat at 482 F and 1000 psi, 3000 lb of steam was produced per hr at 200 psia, generating 150 kw of electricity. Designs of major items of equipment and the shield are described and the cost of construction is summarized.

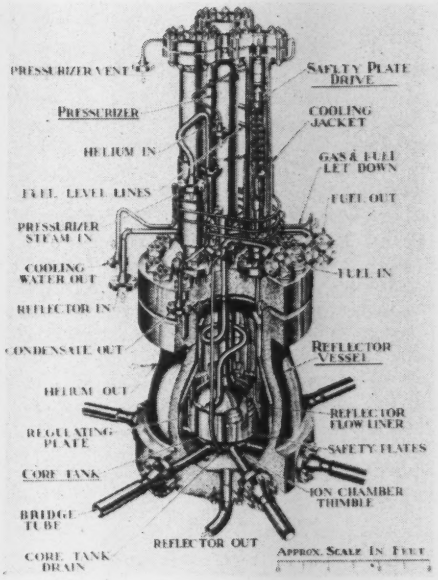

Fig. 1 Reactor-tank assembly of the Homogeneous Reactor Experiment

Table 1 Basic Design Data

Design power level (kw of heat)	1000
Net electric power, kw	120
Auxiliary power consumption, kw	30
Fuel composition	UO_2SO_4 in H_2O
Outlet temperature, deg F	482
Inlet temperature, deg F	410
Operating pressure, psia	1000
Flow rate through reactor, gpm	100
Steam conditions, full load, psia sat	200
Steam conditions, no load, psia	360

In 1950 the Oak Ridge National Laboratory undertook the task of designing, building, and operating a pilot-model liquid-fuel nuclear reactor, the Homogeneous Reactor Experiment. The purpose of this plant was to investigate the chemical and nuclear feasibility of maintaining a nuclear chain reaction in an aqueous solution at a temperature sufficiently high for the production of electric power from the thermal energy released.

Some of the problems anticipated in the design were:

1 Radiation decomposes the water molecules into hydrogen and oxygen. Would the generation of these gas bubbles within the liquid core cause nuclear instability?

2 How could the hydrogen and oxygen produced by decomposition of water be recombined and returned to the system? It was estimated that the decomposition rate would be sufficient to convert all the water in the fuel solution to gas within a few hours.

3 It was expected that the reactor would have self-regulating properties. Would it be self-regulating as hoped, or would a fast-acting control system be required?

4 How would gaseous fission products be disposed?

5 How would leakage be kept low enough to prevent serious contamination and loss of valuable materials? The radioactivity of the fuel solution would be approximately 30 curies of gamma radiation per cubic centimeter. Hence permissible leak rates were of the order of magnitude of 0.1 cc of helium per 24 hr to 1 micron absolute pressure.

Contributed by the Power Division and presented at the Diamond Jubilee Spring Meeting, Baltimore, Md., April 18–21, 1955, of The American Society of Mechanical Engineers. Paper No. 55—S-15.

Description of System

Some of the basic design data for this reactor are given in Table 1.

The construction features of the reactor vessels are shown in Fig. 1. Nuclear energy is released in the reactor core, a stainless-steel spherical vessel 18 in. diam, through which the solution is pumped with vortex flow. The core vessel is surrounded by a heavy-water reflector approximately 10 in. thick, which is kept at the same pressure as the core. Thus only the outer vessel is designed for the high pressure. The core vessel is suspended inside the pressure vessel by its inlet and outlet pipes from a flat bolted head. Also mounted on the head are three control-element drive mechanisms and a steam-heated pressurizer for the core system. The control elements consist of plates, containing neutron-absorbing material, which may be lowered into posi-

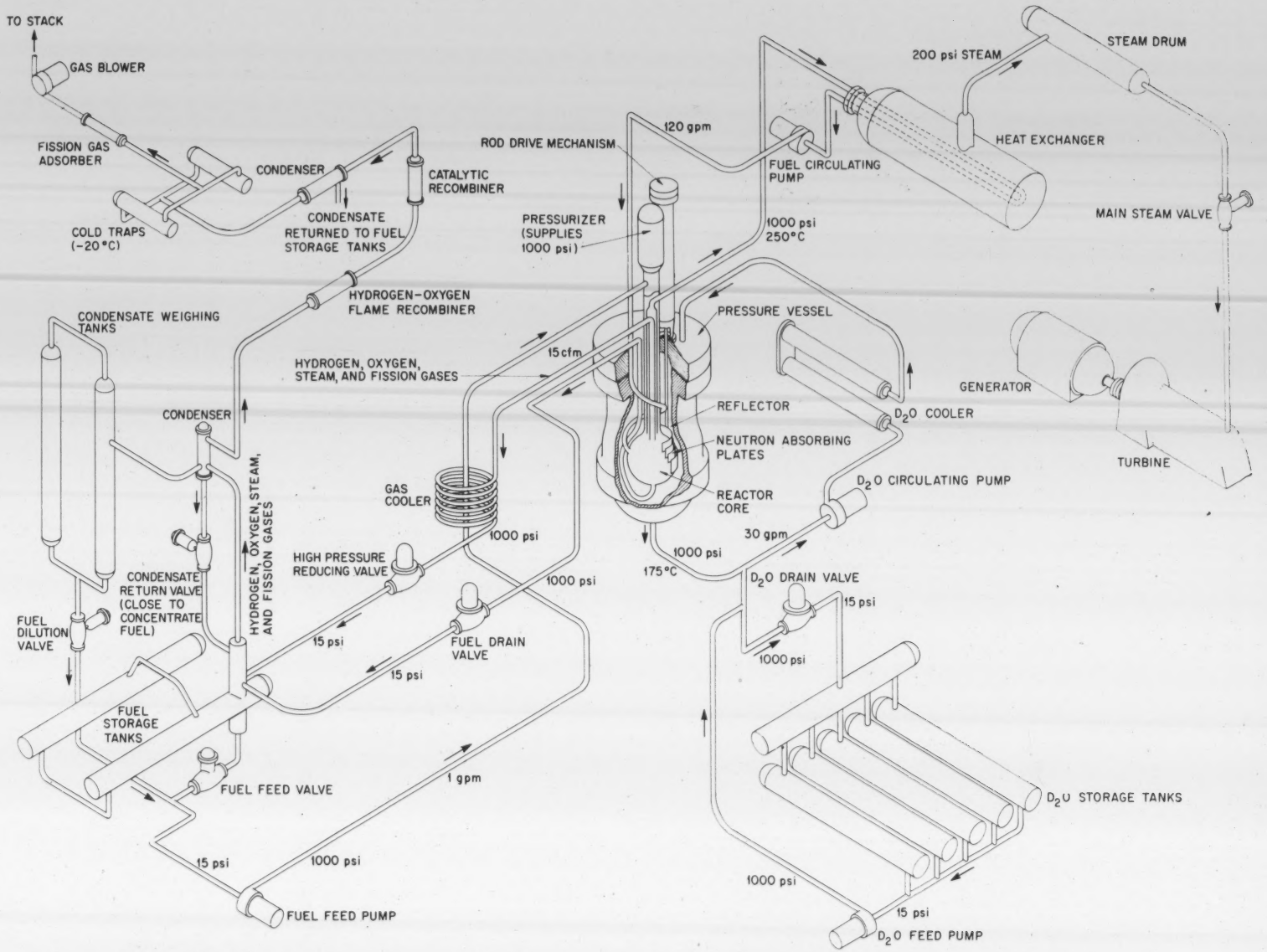

Fig. 2 Schematic flow diagram showing equipment and conditions of fuel system and reflector system throughout entire reactor operating cycle

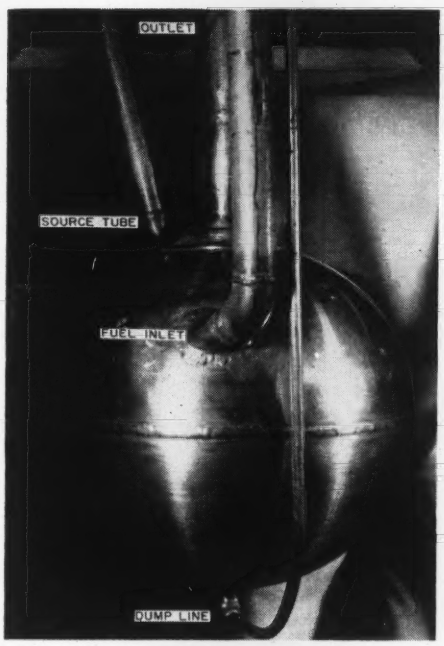

Fig. 3 View of reactor-core vessel taken during construction

tions against the outside of the core vessel, thus shielding the core from the reflector and reducing its reactivity. The pressurizer consists of a chamber, connected with the core, which is heated by steam in a jacket to generate 1000 psia vapor pressure above the solution level. Gas outlet, fuel-solution outlet, and pressurizer stem are concentric pipes extending from the top of the core through the pressure-vessel head. Motors and mechanisms for moving the control elements operate in an atmosphere of helium which also is the reflector-pressurizing medium.

Two essentially separate fluid systems comprise the entire reactor system, Fig. 2. They are the fuel system and the reflector system. Each system is divided into high-pressure and low-pressure parts separated by valves and feed pumps. The high-pressure portion of each system consists of a circulating pump, a heat exchanger, and the reactor vessel, connected by high-pressure piping. Heat is generated by the fission process in the fuel solution flowing through the core vessel and is removed in the heat exchanger and in the D_2O cooler. The fuel-system heat exchanger is a steam generator and the D_2O cooler is a feedwater heater.

Core Vessel. The core tank is made of two hemispheres press-formed of $^3/_4$-in-thick stainless-steel plate, machined inside and outside to a finished inside diameter of 18 in. and thickness of $^3/_{16}$ in. and welded together. The stem welded to the top is 3-in. schedule 80 pipe containing two concentric tubes. The smaller is for removal of gas from the vortex. The other forms the flow annulus through which fuel leaves the core.

Under steady-state conditions the size of the gas vortex in the core is controlled by a valve in the gas letdown line in response to a liquid-level controller on the pressurizer. Enlargement of the vortex forces liquid into the pressurizer causing the level controller to open the valve and reduce the vortex diameter. A continuous liquid feed tends to raise the level also so that some liquid must be removed with the gas. Thus the vortex is always held at a diameter small enough so that some liquid is drawn into the gas-removal hole at the top. The vessel is shown in Fig. 3.

Pressure Vessel. The pressure vessel is a single forging of A105 steel, minimum thickness of 3 in. The flat head is 10 in. thick, also forged of A105 steel. Stainless-steel pipes are sealed to the head by welding.

Pressurizer. The pressure in the fuel system is maintained by a steam-heated pressurizer. The jacket around the lower section is supplied with steam from a small electrically heated boiler whose electric power input is controlled by a pressure-sensing element connected to the top of the pressurizer. Level of solution in the unit is controlled by a specially designed level-control device.

The pressurizer is an all-welded assembly of Type 347 stainless-steel pipe and fittings designed in accordance with the 1949 Unfired Pressure Vessel Code for an internal pressure of 2000 psi at 600 F.

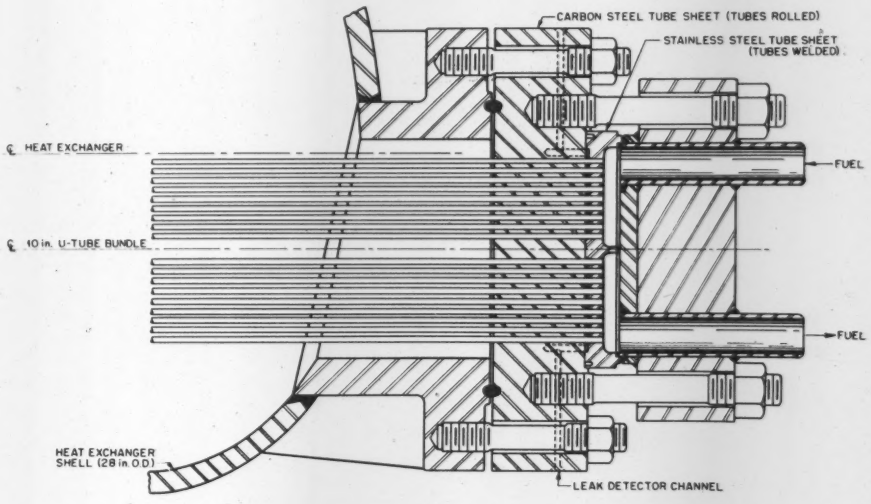

Fig. 4 The steam-generator tube header showing the main details of construction

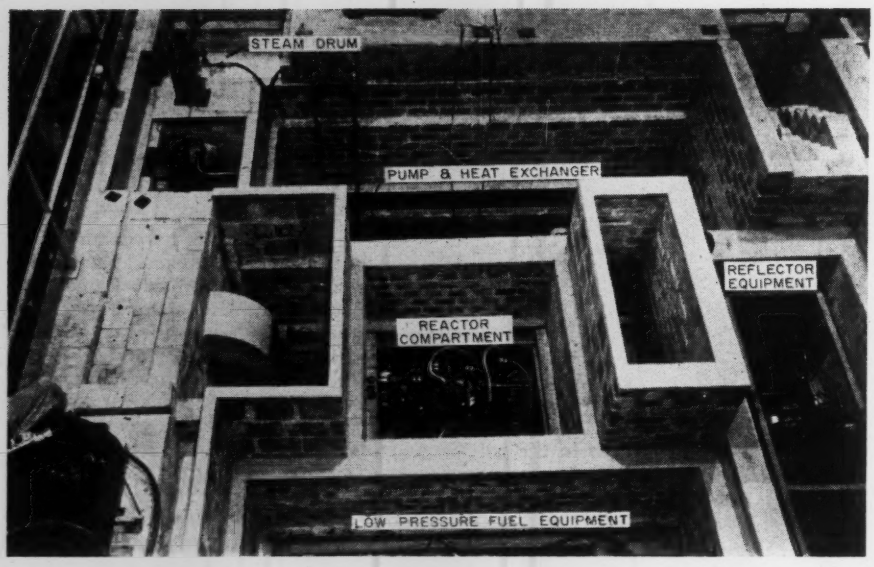

Fig. 6 View of the shield during construction showing compartmentalization

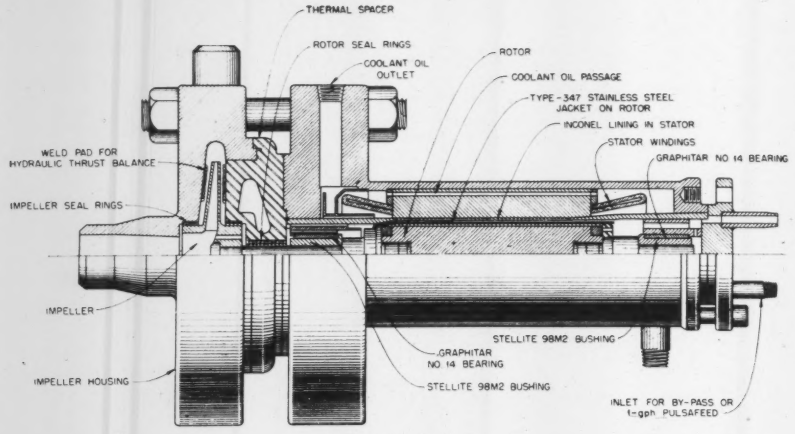

Fig. 5 Canned-motor pump for circulating fuel solution

Steam Generator. The main heat exchanger is a tube-and-shell type with the tubes bent into a U-shape. Fuel solution circulates through the tubes to generate steam in the shell. A double tube sheet, Fig. 4, is used with tubes expanded in one and welded to the other. A connection into the space between them provides indication if a leak develops in any of the tube joints, before it can contaminate the steam. All surfaces in contact with fuel solution are of Type 347 stainless steel, but the shell and back tube are ASTM-A212 grade B carbon steel.

The flow of fuel solution and its average temperature are constant.

Circulating Pump. The pump used for circulating the fuel solution, Fig. 5, is a canned-motor type capable of delivering 100 gpm at a head of approximately 100 psi. Leakage is eliminated by elimination of the shaft seal. The increased air gap between stator and rotor in the motor, however, results in efficiency of only 34 per cent.

Gas-Removal System. Gas, vapor, and liquid from the vortex in the core vessel are removed through a throttling valve which discharges into the low-pressure system. The throttling valve is controlled by liquid level in the pressurizer. Part of the pressure drop, approximately 180 psi, occurs in the annulus of a concentric-tube heat exchanger in which the temperature is reduced to 183 F before reaching the valve.

Recombiners. The mixture in the letdown stream is separated in the dump tanks and the gases are recombined either in the flame recombiner or in the catalytic recombiner. The flame recombiner consists of a combustion chamber, a nozzle, and a spark plug. The gas is ignited as it emits from the nozzle and forms a flame down the center of the chamber. The chamber walls are cooled by a water jacket. Products of combustion are desuperheated and condensed, condensate being returned to dump tanks and pumped into the reactor by the feed pump.

The catalytic recombiner is a packed bed of platinum-coated alumina pellets. In passing over the platinized

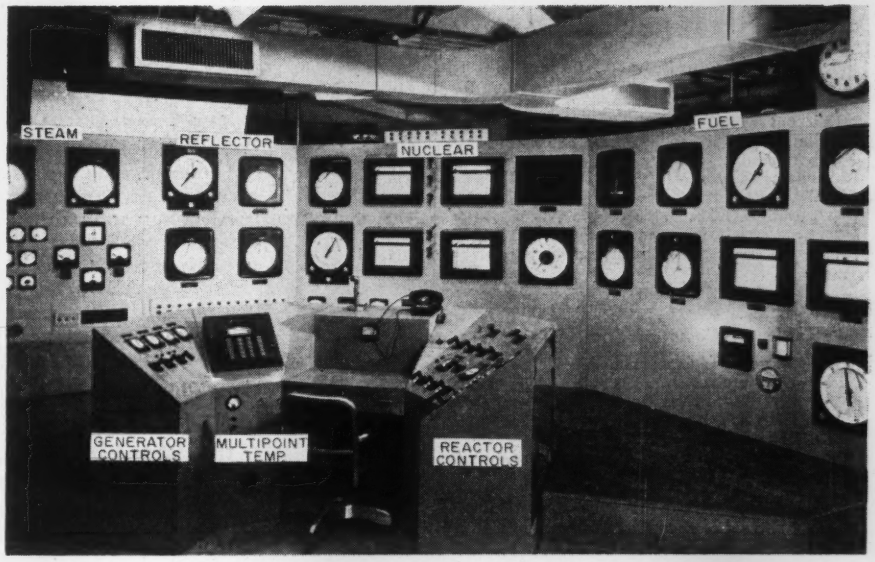

Fig. 7 All of the important instruments are located in a central control room

surfaces the hydrogen and oxygen recombine, emitting the heat of combustion. Unless the entering gas is diluted below the combustible concentration an explosion will result. Consequently steam is mixed with the gas to make it nonexplosive.

Noncondensable gases consisting mostly of krypton and xenon fission products are absorbed in a charcoal bed where they decay to lower levels of activity before being pumped out the stack.

Feed Pump. Solution is pumped up from the low-pressure system to the high-pressure system by means of a hydraulically actuated diaphragm pump.

Valves. All valves in contact with either fuel solution or reflector fluid are of the bellows-sealed type and are operated by specially designed bellows air operators. The bellows seal is backed up by a packing and the intermediate space is connected to a leak-detection system.

Piping and Flanges. The piping system is all-welded except in places where removal of component equipment is anticipated. In such cases as the circulating pump, where failure of the thin can is considered to be probable, flanged pipe joints are provided. All flanges used at 1000 psi operating pressure are ASA 2500 pound standard, welding-neck type of solid stainless steel.

In fabrication of equipment and piping, all welds were completely radiographed and Dycheked. All detectable defects were chipped out and rewelded or the part was rejected. All pipe containing reactor fuel solution is seamless and wall thicknesses conform to the American Standard Code for Power Piping. Vessels are designed and constructed in accordance with the ASME Boiler and Pressure Vessel Code, 1949 edition.

Radiation Shielding. The radiation shield for the HRE, Fig. 6, is constructed of solid blocks of a special concrete, part laid in mortar and part stacked dry. The concrete is a mix of Portland cement and barytes aggregate with a resulting density of 225 pcf. Space inside the shield is compartmented to reduce to a minimum the radiation level in any one compartment and thus facilitate maintenance. Since the reactor vessel is the most intense source, it is in a center compartment surrounded by a minimum of 7 ft of concrete at least 2 ft of which separate it from the nearest auxiliary compartment. The inner 2 ft of concrete contains 1 per cent boron in the form of colemanite ore to increase its absorption for neutrons with minimum resultant induced activity. Each compartment may be opened at the top by lifting barytes concrete covers. The entire shield structure measures 22 ft wide, 26 ft long, and 18 ft high.

Emergency Cooling. As a matter of safety, a cooling system is provided which will dissipate all heat due to decay of fission products after shutdown, without dependence upon any outside source of water or electric power. This is accomplished by a natural-convection water system connecting dump-tank cooling jackets with air-cooled finned tubes outside the shield. This system is capable of removing 95,000 Btu per hr for a short time and 45,000 Btu per hr continuously.

Steam System. The steam system in this plant has the characteristic that its steam pressure increases as the load decreases. At the design load of 1000 kw the steam pressure is 200 psia, whereas at zero load with the reactor critical at its normal temperature the pressure is 360 psia. When load on the turbine is suddenly reduced, pressure rapidly builds up in the steam generator, reducing the temperature difference to just that required to transmit the demand load. Reactor-fuel temperature is held constant by the negative effect of temperature on reactivity. Rise of temperature in the core causes the solution to expand, expelling solution, and consequently uranium, from the core and reducing its tendency to react. Operation has proved this a stable characteristic.

In the steam generator, only 0.049 in. of stainless steel separates the core solution from the boiler water. Although delayed neutrons are emitted in this part of the loop, induced activity in the steam is low enough to permit operation with no shielding around steam lines or

Table 2 Summary of HRE Construction Cost

	Cost	Per cent of total
Building, utilities, roads, walks, site development, etc.	$ 300,414	27.5
Fuel and reflector equipment and piping (materials only)	159,346	14.5
Installation of fuel and reflector equipment (labor and overhead)	259,776	23.7
Instruments and controls (materials only)	52,876	4.8
Installation of instruments and controls (labor and overhead)	139,910	12.8
Shield—materials, labor, and overhead	106,305	9.7
Power system—materials, labor, and overhead	75,535	6.9
Total cost	$1,094,162	100

Table 3 Costs of Some Major Equipment Items

Core vessel (approximate)	$ 5000
Pressure vessel	18500
Steam generator	5000
Circulating pump (fuel)	9000
Diaphragm pump head	1900
Diaphragm pump actuator	5900

turbine. However, if one of the tubes fails or develops a leak, the steam will contain very radioactive gases and vapors from fuel solution, endangering the operating personnel. As a precaution against this the steam goes into an accumulator inside the shield which provides a minimum of 14-sec time delay in the steam flow at design power level. A radiation monitor on the steam pipe entering the accumulator is shielded against reactor radiations and is sensitive to activity in the steam. The monitor provides a signal for automatic closing of a valve in the exit line from the accumulator. The same signal causes a valve to be closed in the feedwater line thus isolating all activity inside the shield.

Outside the shield the steam system is made up of conventional equipment for this type of system. Electric output of the generator is synchronized into the laboratory power system, which is served by the Tennessee Valley Authority.

Instrumentation. All important indicating, recording, and control instruments are located on panels in the central control room, Fig. 7. Designs of the panels and control console are such that a single operator seated at the console can reach handles controlling all important operations of the reactor, turbine, and generator. From the same position he can read all pressures, temperatures, flow rates, and nuclear levels on the large panels. A panel on the main board indicates to him which valves are open and which are shut, and an adjacent bank of air valves enables him to open or close remotely any valve inside the shield not controlled at the console itself.

Temperatures are measured by thermocouples connected to instruments in the control room. Pressure and liquid level are transmitted electrically from detectors inside the shield to the control-room instruments.

Cost of Construction

A breakdown of cost of construction of the Homogeneous Reactor Experiment is given in Table 2. These costs do not include costs of fuel and heavy water. It is interesting that installation of reactor equipment, piping, and instrumentation total 36.5 per cent of total costs whereas materials costs for the same items total only 19.3 per cent.

Several factors contributed to the high labor cost: (1) The 48-hr week was in effect for the entire job and accounted for about a 10 per cent increase in labor charges. (2) Specified welding and inspection requirements were in excess of then standard laboratory practices. Welder training costs and establishment of more rigid inspection methods were charged to the job, increasing the labor-overhead bill as much as 20 per cent. (3) Some design changes during construction were necessary owing to concurrent laboratory development work.

Although approximately one-third of the high-density concrete cost $105 per yard as concrete blocks, the average cost of the completed shield was $290 per yard.

In Table 3 is given a list of costs of some items of equipment. All these items except the core vessel were obtained from commercial fabricators competitively.

Operating History

The HRE was in operation intermittently over a period of two years. During that time the following totals were accumulated:

Total hours with liquid circulating	4498
Total hours with reactor critical	1950
Total hours at reactor power over 100 kw	720
Maximum reactor power level attained	1600

Kinetic experiments have been performed in which uranium has been suddenly introduced at a rate of 75 grams per sec. Doubling times as short as 30 ms were attained. The power arose from 30 watts to 11×10^6 watts in 1 sec, and returned to normal in another 0.1 sec. In this experiment the worst combination of circumstances was imposed on the reactor. It was demonstrated successfully that the HRE was sufficiently stable, nuclear-wise, to withstand transients greater than those to be expected from operating errors.

Leakage experience with the reactor has been satisfactory. Although several leaks were experienced in the start-up phases, no leakage was found during the final 12-month period. Leaks are detected quickly by radiation detectors constantly monitoring the ventilating air, so the reactor can be shut down and drained before a large amount of solution is lost.

Although maintenance repairs are difficult to make, it has been possible to execute a number of major repairs in radiation fields as high as 200 R/hr, without exposing personnel beyond established tolerances. In no case of a breakdown has it been impossible to make the necessary repairs.

The entire reactor has now been dismantled so that the building and auxiliary equipment may be used for more advanced pilot-plant experiments.

Acknowledgments

The design, construction, and operation of the Homogeneous Reactor Experiment is an accomplishment of many scientists and engineers of the Oak Ridge National Laboratory operated for the United States Atomic Energy Commission by Carbide and Carbon Chemicals Company. The author is grateful for the privilege of representing them in making this presentation. Special recognition is due Dr. C. E. Winters and Mr. S. E. Beall[1] for data, information, and comments.

[1] See "The Homogeneous Reactor Experiment, A Chemical Engineering Pilot Plant," by S. E. Beall and C. E. Winters, *Chemical Engineering Progress*, vol. 50, no. 5, 1954, pp. 256–262.

Management Aspects of Air Pollution

Good public relations can be a powerful adjunct in industry's struggle for clean air

By G. Edward Pendray

Pendray and Company, New York, N. Y. Member ASME

Not only the United States, but also much of the rest of the industrialized world, now has an air-pollution problem. It is more of a problem in some localities than in others. Virtually every town and city of any size in the United States is seeking, by policing, regulation, or moral suasion, to reduce its air-pollution problems.

The American Municipal Association has reported, that of all cities in the country of 25,000 population or over, only four had not established some form of air-pollution control. Probably these four have joined the procession by now.

Economic Loss from Air Pollution

There is good reason. Weldon B. Gibson of Stanford Research Institute, estimates that direct economic losses from air pollution amount to at least $1,500,000,000 per year in the United States—something over $10 per person per year, measured in terms of the extra costs of cleaning, painting, laundry, damage to merchandise and buildings, and the like.

Air-pollution problems are placing a heavy burden on industry. Estimates of industrial expenditures are difficult to get, because some companies do not segregate this type of expense from other construction costs, and some, for one reason or another, do not care to give out the figures. From such data as are available, researchers have come up with estimates ranging from $100,000,000 to $300,000,000 annually. The indications are therefore that industry may have spent as much as a billion dollars in the past five years trying to clear up its share of the country's air-pollution problem.

This is a real addition to the cost of doing business in this country—and management as well as the public had better take stock of where we are and where we are going.

It seems to me we need to consider, especially, two questions:

1 Is there any less complaint today about air pollution than there was five years ago, before all this money and effort had been spent? In short, are things getting better?

2 Is the high cost of air-pollution control going to keep on indefinitely—an ever-mounting charge, or is there some end in sight?

As to the first of these questions, it must be admitted that there is no objective way of measuring whether the situation is really getting better or worse. Air pollution itself can be measured to some extent, of course, but it is a common experience that the indignation of the people is not necessarily in direct ratio to the amount of pollutants in the air.

In many communities, the improvements brought about by the larger industrial plants, and by joint efforts, have been a very great help. One needs only to consider such outstanding examples as St. Louis and Pittsburgh to realize that communities can be cleaned up.

But in others the efforts of industry have not always abated the nuisance. They have merely disclosed numerous secondary sources of pollution: the smaller plants, the apartment incinerators, the private coal-burning homes, and other sources. Since it is always easier to blame the big fellows, industry in some of these areas still continues to carry the principal onus, though no longer primarily at fault.

Surveys on Air Pollution

Recently, in connection with some of our work, my associates made two surveys bearing on air pollution.

The first was a poll among public-enforcement officials with regard to odors. This survey indicated that the problem of odor control may be the next big one to confront industry, particularly the food-processing, paper, chemical, rendering, plastics, and pharmaceutical industries.

Public-enforcement officials report receiving many complaints about odor. The number of such complaints is increasing. As an air-pollution problem, it now ranks fourth—the others being smoke, fly ash, and dust, in that order.

The second recent survey was among 175 industrial managers, made as a means of determining something of the climate of industrial opinion on this question. The companies queried were all large ones. They were all known to have been active in one way or another in connection with air-pollution control. So, this survey reflected enlightened or experienced company opinion, as opposed to that of industrial managers who may still be resistant to pressures for improvement.

Seventy-two per cent of these enlightened industrial managers reported that the air-pollution situation in their operating communities is getting better. Only 20 per cent thought the situation was about the same as five years ago, or worse.

When asked what is now the principal cause of air pollution, nationally, 53 per cent of these industrialists named industry as still the principal cause; 49 per cent gave first blame to vehicles, and 38 per cent to private dwellings.

The principal obstacle to more rapid improvement named by 55 per cent of these respondents was the cost of equipment. An equal number named the principal ob-

Dinner address contributed by the ASME Committee on Air Pollution Controls and presented at the First International Congress on Air Pollution of The American Society of Mechanical Engineers, New York, N. Y., March 1–2, 1955.

stacle as lack of technical knowledge. But just plain, ordinary inertia was blamed by 27 per cent, or more than one fourth.

One respondent said: "The engineers already know a lot more about how to cure pollution than industry generally is willing to use."

As to their own company air-pollution problem, 35 per cent of the managers felt they had already completely solved it. Another 29 per cent reported that it had been almost solved. But 20 per cent—one fifth—stated that their company problem had not yet been solved.

It has often been suggested that there should be changes in the Federal tax laws which would encourage more rapid expenditures for air-pollution control. More than half, or 51 per cent, of the managers agreed that there should be such changes in the tax laws; 26 per cent were opposed.

Seventy-three per cent stated that in their companies air pollution is considered as a major factor when new construction is planned. The average percentage of new construction costs in the past five years devoted to this purpose by companies responding to this question was a little over 5 per cent.

Some surprisingly large 5-year expenditures were reported for air-pollution control. These ranged from $1700 in the case of one company to $20,000,000—the latter being the expenditure of the Consolidated Edison Company in New York. This was in addition to $11,000,000 spent by Consolidated Edison prior to 1950, and another $15,000,000 which that company expects to spend for this purpose in the next half decade.

In fact, 26 per cent of the major companies we pooled expect to spend impressive sums on air-pollution control in the next five years. The sums to be spent by these companies total $52,730,000. And if past experience is any criterion, most of this will be a pure investment in community good will. Little or none of it will come back in the form of valuable materials.

Only 2 per cent of the companies reported the recovery of all costs of air-pollution control. Thirty-six per cent reported that some costs were recovered. But 44 per cent had no recovery whatsoever.

Now industry has been paying a lot of attention to air-pollution control. It has been spending huge sums of money. In addition, several major industries have organized nationwide activities to make sure that companies in their fields are taking full advantage of the latest knowledge to control air pollution.

Yet industry generally is still getting the major blame. The question naturally arises, if industry has done so much, why isn't it receiving appropriate credit? I believe it is because of the way industry handles the matter.

The Plant Manager's Responsibility

It is most often the local plant manager or the small local industrialist—and not the big industrial statesman back at company headquarters—who has to deal with the problems of air pollution, and he is the man who so often makes heavy weather of it.

The local industrial manager indeed often finds himself in a curious, frustrating situation, at least from his point of view. He is successfully running a plant to produce goods that people need and want. He is constrained by the hard laws of economics to produce these goods at lowest possible cost—yet to sell them for enough to make a profit. Often he is beset by competitors who have advantages that he may not have—and any small increase in the cost of running the operation may well mean the difference between being able to compete or losing out in the race.

The Community Problem

While air-pollution control may be basically technological in method, the community problems that arise out of it are principally psychological ones. Mere abatement of the actual pollution often will not solve the community-relations problems it has stirred up—especially when, as too often happens, industry acts too late, with too little—and handles the whole matter in the style of a sulky little boy being forced to wash his hands and face before coming in to dinner.

The community should, in his opinion, appreciate the job he is doing. Among other things he is providing work for its citizens and a market for local products and services. Yet, just because now and then his plant has been emitting smoke or fly ash, or possibly some bad odors, he finds himself under criticism. The local newspapers have assailed him with editorials. Lawsuits may be hanging over him.

The Air-Pollution Syndrome

Under these circumstances the average plant manager is likely to react according to what, in our practice, we have come to recognize as the industrial "air-pollution syndrome." I first described this reaction pattern more than five years ago, in a paper given before the Industrial Hygiene Foundation in Pittsburgh, Pa. It was my somewhat naïve expectation that a recital of the sequence would help others to avoid its pitfalls. But only as recently as last month at least one major plant in a city not far from New York was following the pattern. In one way or another, it is being followed throughout the country—possibly throughout the world.

Local managers of industrial plants often are still of the old tradition when it comes to air-pollution matters. When complaints are first made about smoke, fly ash, fumes, or whatnot, two sorts of self-contradictory replies are commonly made.

The first is generally to the effect that it isn't so. The plant isn't actually putting out any such smoke, fumes, fly ash, or other pollutants. I have known instances where this kind of retort was made even though, at the very moment, visible clouds of smoke were pouring from the stacks, and fly-ash particles were falling all around like gentle rain. Obviously, this answer satisfies nobody. But it convinces both the friends and opponents of the management that the plant will not take a friendly hint.

When agitation increases, the plant manager's next retort is likely to be to the effect that—well, it's an industrial area. The plant was there long before the town grew to its present size. If people want to move into an industrial community they must be prepared to take the consequences.

The net effect of this is to make everybody mad. An antiplant movement is likely to begin taking organized form. There will presently be meetings, speeches, and

letters to the editor of the paper. Before long, an organized and vocal opposition develops—an opposition that has become convinced that political or legal action is necessary to make the plant take the steps required.

At about this point the management is apt to enter the discussion again, possibly by asserting that "crackpots"—or even "communists"—are leading the movement. It is true that leaders of such movements are sometimes hotheads, speechmakers, possibly even adherents to anti-business philosophies. But the situation usually isn't of any leftist's making. It is the result of the plant's own handling. The strength of the cleanup faction doesn't lie in radical leadership, but in the conviction of a lot of sound, honest, capitalist-thinking people that the plant could and should clean up—but that it will do nothing until it is forced to.

Now, at this point, the manager asks the advice of legal counsel. Lawsuits are being talked of. Maybe some have actually been filed. The lawyer generally counsels that to make any kind of statement, other than denial, may constitute an admission of fault—and therefore be costly.

So the plant management, which up to this time may have handled the matter only blunderingly, now takes a worse step. It begins to act guilty. It refuses to discuss the pollution problem, perhaps even maintaining there is none. A delegation of citizens comes to discuss the question, hoping to find a meeting of minds, or to be able to report progress. The management may refuse to see them, or may have a lawyer present to do the talking. The local paper may send a reporter out, possibly to do a friendly story, with a view to helping the management off the spot. The reporter gets barred at the gates, or is told that the company has "no statement for the press," or is handed a brief denial of all guilt, patently written by an attorney.

The Fireworks Start

Well, by this time the stage is set for real fireworks. What started out to be a simple problem of dealing with a natural and proper community desire for better living has by now been blown up into a holy crusade against the company—and possibly against the rest of industry in the community, too. Employees find themselves in disfavor with their neighbors. The management has failed to explain the situation to them, so they don't know how to reply to the attacks. They may begin to agree with the agitators. The company now has an employee-morale problem added to its air-pollution difficulties.

Presently a pollution ordinance is passed. Or if the community already has one, it is toughened up, and given teeth. A policeman is appointed to deal with the plant. Regulations are adopted as to the permissible amount of smoke, fumes, pollutants, and the like—often without any idea of their effect either on the nuisance under attack, or on the economics of the community. The plant at last is forced to yield—to take the remedial measures which, had they been undertaken voluntarily two or three years earlier, would have made new friends and gained the company credit for public spirit. But now, though the cost is the same—or maybe greater—the company comes out of the quarrel with a black eye. Its employees are confused and alienated. All private industry has received another setback in the community. And industry gets no credit for what it has done in controlling air pollution, since it so obviously has been forced to do it.

Unfortunately it is not possible to tell how widespread situations of this kind are today. There are a great many more of them than most industrial managements know about, or will admit. Our work brings us in contact with a number of them, and it is amazing how, even in cities where industry possesses organization for a concerted attack on air-pollution problems, these weapons are not being used effectively. Sometimes they are not being used at all.

Cleanup Demanded

I know of one Midwestern city where the local Manufacturer's Association has set up a fine-sounding Air Pollution Control Committee. Its members include representatives of the city's leading industries. There are several plants in this city that have done literally nothing—except make promises—to solve one of the most shockingly bad smoke and fume-pollution situations in the country. And what has been accomplished by the Air Pollution Control Committee? Nothing. It doesn't even meet. Some of the members have told us that the committee is afraid to acknowledge the existence of the pollution problem, because then the community will demand too drastic a cleanup.

But, in the meantime, the community is demanding a cleanup anyway. A Citizen's Committee on Air Pollution has been organized—and it meets. In this city not just one plant is going through the industrial "air-pollution syndrome" now; all the community's industry seems to be following that foolish course. The outcome, of course, will be just what might be expected. It takes a certain belief in sympathetic magic to follow the industrial air-pollution syndrome. One must firmly believe that if the fact of air pollution just isn't acknowledged, somehow it will vanish of its own accord.

On the other hand, there are many communities where the investment of major companies in air-pollution control, and intelligent community-relations practices, have really begun to bear fruit.

Solving a Difficult Public-Relations Situation

One of the most difficult air-pollution problems I know about, and one which has been as well and successfully handled as any in the country, is that of the Kaiser Steel Corporation at Fontana, Calif.

When this plant was built in 1942, there were no effective devices for controlling open-hearth and sinter stack emissions. About all the company could do was erect

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A Disease of Increasing Population

Air pollution is not just an industrial, not just a local problem. It is, instead, another significant index of the changes coming over the world because of our enormously growing, terrifying, burgeoning world population. Air pollution is one of the diseases of increasing population—an environmental fouling, brought about by the very metabolism of the huge, sprawling, mushrooming human organism clustering over the surface of the earth, subduing every past and present resource to its need.

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stacks that were higher than usual in order to obtain the greatest possible dispersion.

Since then, precipitator units have been successfully installed in two open-hearth stacks, but seven stacks are still uncontrolled and units cannot be installed in these until 1958.

Fontana is located at the west end of San Bernardino County, about 50 miles from Los Angeles, and is therefore in an area very sensitive, these days, to smog. But Kaiser Steel has escaped a great deal of the public attack and contumely heaped on other industries in the area simply by telling the community what its problems are, what it is doing about them, and what cannot be done.

The first step was to set up an "Open House" policy at the plant, inviting the public to come and visit. Large groups of county and city officials, smog-control groups, agriculture experts, parent-teacher groups, doctors, ministers, social and fraternal organizations, newspaper groups, and others are brought into the plant, inspect its air-control and research laboratory, and examine the open-hearth precipitators. More than 150,000 people have gone on such conducted tours during the past six years. The groups are addressed, and questions answered, by well-informed and well-trained members of the company.

The program does not stop there. Newspaper publicity releases and newspaper advertisements are used to reach the people who cannot come to the plant in person. The staff has taken part in an elaborate public-information program—making numerous talks and giving papers before civic, club, university, and scientific groups. They have gone out of their way to meet and talk with especially annoyed people, such as writers of "Letters to the Editor," to discuss their complaints or questions.

Kaiser has told its 6500 employees the story, too. As a result, many of them have become volunteer ambassadors of good will in the community.

Now, this cannot be just a fancy way of side-stepping the problem. Kaiser ultimately will have to find technological ways to cure its air-pollution problem, of course. But in the meantime, its community program is buying both the necessary time—and good will as well.

A Community-Relations Opportunity

Many another company has similarly discovered that air-pollution problems can be turned into community-relations opportunities. I know of several that have gone through the air-pollution syndrome, and as a means of clearing up its aftermath have organized complete and effective community-relations programs—then to discover, with delight, that these activities have brought them great and unexpected gains in better employee morale, better community and supplier co-operation, and enhanced reputation.

Indeed, a large part of industry is making this kind of discovery, and will find increasingly in the future that good community relations pay. This is a good thing, too—for in my opinion the necessity to control air pollution will not diminish in the future. It will grow. It will be vital for us to seek every possible collateral advantage out of it.

The Growing World

In the United States our population was only a little more than 5,000,000 in 1800—about the present total population of the state of Massachusetts. By 1900 it had increased more than 15 times—to 76,000,000. From 1900 to 1950 it again doubled, to more than 150,000,000. It is now about 165,000,000. It continues to increase at the rate of nearly $2^1/_2$ million each year.

Population over the whole world is following a similar growth curve. There was little air pollution in the world in the year 1750. The total population of the entire earth at that time was only about 800,000,000. By 1900, however, it had grown to a billion and three quarters. In 1950, it stood at 2,400,000,000. The rate of growth is such that some demographers are predicting 4 billion people by the year 2000.

This kind of increase literally could not be possible, of course, except for the increasing industrialization of the earth. In the United States, the total value added of all manufacturing industry in 1850 was less than half a billion dollars. By 1947 it had reached a total of nearly $75 billion.

Industry demands power—in enormous quantities. Power generation for the most part requires the burning of fuels. Take electric power, as an example. Twenty-five years ago, in 1930, production of electric energy in the United States consumed 40,000,000 tons of coal, 9,000,000 barrels of oil, and 120 billion cubic feet of gas. By 1952 these figures had climbed to 107,000,000 tons of coal, more than two and a half times the amount burned in 1930—67,000,000 barrels of oil, or better than a seven-fold increase—and 912 billion cubic feet of gas, eight times as much as a quarter-century ago.

The millions of tons of combustion products now being poured into the air all over the world staggers the imagination. When climatic conditions conspire with output, as sometimes occurs, to retain or entrap some of this effluent in geographical pockets that also happen to be densely populated, it is no wonder that irritation sets in, tempers are aroused—and fears are loosed that sometimes demand action greater than the cause warrants.

I do not think that anything in our lifetime is going to stop this world-wide growth of population—or the growth in industry and use of fuels that naturally will accompany it. As population grows, the problem will increase, both in intensity and complexity, along with the traffic problem, the housing problem, and all the other problems that increasing numbers of people will bring into being.

Get Set for Action

In air-pollution control, whatever is good enough today will not be good enough tomorrow. And whatever is not good enough today will soon be absolutely intolerable. Toward greater population seems to be the way things are inevitably going. We had better get ready, therefore, to make living as pleasant as possible under the circumstances. In this, the greatest burden will continue to fall on industry. It will be another of those challenges that seem to require an ever-growing degree of statesmanship in management. It is vital that enlightened management meet this challenge.

Ultrasonic Attenuation Measurements . . .

. . . for Study of the Engineering Properties of Materials

By Rohn Truell

Director of Research, Division of Applied Mathematics, Brown University, Providence, R. I.

A relatively new method of studying the physical properties of materials is presented. It can be used in metallurgy, in many engineering applications of both fundamental value and of immediate practical value, including a number of quality-control applications. It is a method about which a great deal will be heard in the future.

ONLY a limited amount of work has been done in the megacycle range of frequencies in the study of solid materials.[1] The method to be described in the paper involves the measurement or the comparison of ultrasonic energy losses in solids. The evaluation of energy losses is accomplished by measurement of an attenuation or propagation factor.

Technique of Measuring Attenuation

The energy losses are produced in the solid by scattering energy from a beam of energy or by absorption of energy within the beam of energy—or both. The energy in question is introduced into the sample in the form of pulses of microsecond length with a carrier frequency varying from 5 to 500 mc/sec depending on the material being examined and the particular property under examination. The loss in energy is measured by causing the pulses to travel back and forth between two accurately parallel faces of the sample and by measuring the amplitude decay of the pulses as a function of the number of echoes or reflections, hence as a function of the distance traveled in the sample.

The form of the sample and the type of pulse pattern observed are indicated in Fig. 1, where a single pulse is introduced into the sample and allowed to travel back and forth between the parallel faces until it is entirely dissipated, then another pulse is applied and the process repeated. The repetition rate of the pulses is about 300 per sec. The decay of the pulse amplitude as a function of the number of round trips made by the traveling pulse gives the energy loss as a function of distance traveled in the material or as a function of the time elapsed. Attenuation values are then variously expressed as decibels per echo, decibels per centimeter, decibels per microsecond, and so on.

The generation of the pulses and the generation of elastic waves by means of coupling the electrical pulse-generating system to a quartz-crystal transducer are well known.

Measuring Low Attenuation Values. Careful measurements become of great importance with materials having very low attenuation values. Materials such as quartz and silicon single crystals have very low attenuation values even as high in frequency as 500 mc/sec where the wave length in the solid is of the order of 10 microns (10^{-3} cm or 4×10^{-4} in.). Very few materials even in single-crystal form can be subjected to attenuation measurement at frequencies this high because the attenuation becomes too large and there are too few echoes with which to make measurements. Germanium single crystals have a practical upper frequency limit of about 300 mc/sec. The choice of the frequency range in which attenuation work is to be done depends primarily on where in the frequency range the attenuation becomes too high to measure. Ordinarily it is desirable to use as wide a frequency range as possible below the frequency where the attenuation becomes too large.

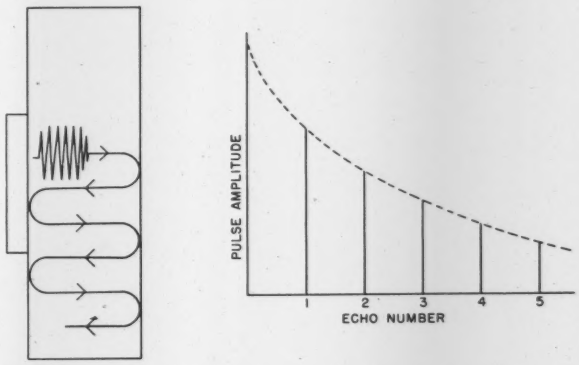


Fig. 1 Form of sample and type of pulse pattern observed

Polycrystalline materials fall into the range from about one mc/sec to 100 mc/sec and most metals

[1] The only previous work of such nature known to the author was carried out by W. Roth at M.I.T., by W. P. Mason and H. J. McSkimin at the Bell Telephone Laboratories, and by R. K. Roney at the California Institute of Technology.

Contributed by the Metals Engineering Division and presented at the Diamond Jubilee Spring Meeting, Baltimore, Md., April 18–21, 1955, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. (Condensed from ASME Paper No. 55—S-17.)

of polycrystalline nature must be studied below 60 to 80 mc/sec.

Work at Brown University

Fig. 2 gives an outline of most of the work undertaken in the Metals Research Laboratory at Brown University; it is not possible here to discuss this outline in detail. Parts of this work are primarily solid-state physics and metallurgy. The outline classifies the energy losses in terms of absorption and scattering. Attenuation is a term including both types of losses.

The remainder of the paper will be devoted to certain sections of the attenuation work which seem likely to be of interest to engineers and especially to those who are concerned with metallurgical problems and with quality-control problems.

An example of a rather large effect which is not yet clearly understood is that of an experiment on a chrome-nickel-molybdenum composition (known as 16-25-6 alloy) where an ultrasonic attenuation comparison has been made among samples of this material subjected to aging by heating. The aging was very pronounced in the samples used as shown in the photomicrograph, Fig. 3. It is evident that there is a directional effect. The aging effect shown in Fig. 3 is that of the precipitation of the dark carbides, and to obtain the pronounced heavy aging the material is heated at approximately 1500 F for 1 hr.

The results of attenuation in the low megacycle region (5 to 15 mc/sec) are shown in Fig. 4, where it is evident that sample 1 is highly attenuating with the ultrasonic waves traveling parallel to the striations, whereas in sample 3 there is the same aged structure but the beam is perpendicular to the striations and the resulting attenuation is very much lower than in sample 1 and even slightly lower than in the normal structures as represented by samples 2 and 4 which have the same attenuation.

Attenuation of Copper-Aluminum Alloy

A second example of this type of work is that where internal changes in a metal or alloy are brought about by producing phase changes or by causing precipitates to form. An excellent example of this type of alteration of the material is that where internal oxidation in a copper-

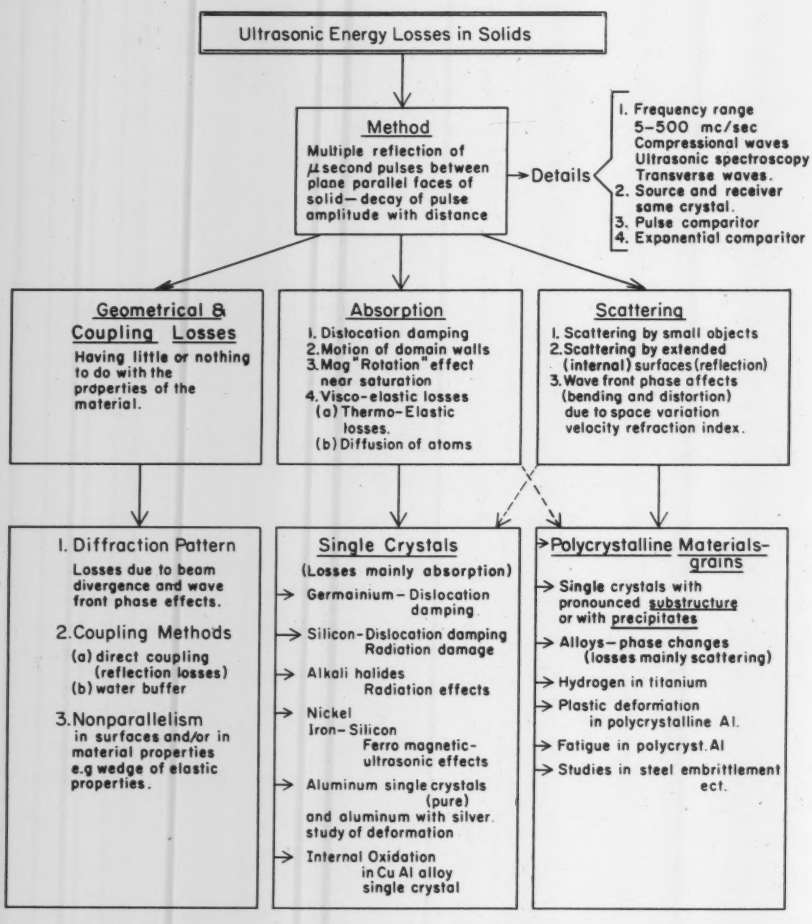

Ultrasonic Energy Losses in Solids
Method
Multiple reflection of μsecond pulses between plane parallel faces of solid—decay of pulse amplitude with distance
Details
1. Frequency range 5–500 mc/sec Compressional waves Ultrasonic spectroscopy Transverse waves.
2. Source and receiver same crystal.
3. Pulse comparitor
4. Exponential comparitor
Geometrical & Coupling Losses
Having little or nothing to do with the properties of the material.
Absorption
1. Dislocation damping
2. Motion of domain walls
3. Mag "Rotation" effect near saturation
4. Visco-elastic losses
(a) Thermo-Elastic losses.
(b) Diffusion of atoms
Scattering
1. Scattering by small objects
2. Scattering by extended (internal) surfaces (reflection)
3. Wave front phase affects (bending and distortion) due to space variation velocity refraction index.
1. Diffraction Pattern
Losses due to beam divergence and wave front phase effects.
2. Coupling Methods
(a) direct coupling (reflection losses)
(b) water buffer
3. Nonparallelism
in surfaces and/or in material properties e.g wedge of elastic properties.
Single Crystals
(Losses mainly absorption)
Germainium—Dislocation damping
Silicon—Dislocation damping Radiation damage
Alkali halides Radiation effects
Nickel
Iron—Silicon Ferro magnetic—ultrasonic effects
Aluminum single crystals (pure) and aluminum with silver. study of deformation
Internal Oxidation in Cu Al alloy single crystal
Polycrystalline Materials—grains
Single crystals with pronounced substructure or with precipitates
Alloys—phase changes (losses mainly scattering)
Hydrogen in titanium
Plastic deformation in polycrystalline Al.
Fatigue in polycryst. Al
Studies in steel embrittlement ect.

Fig. 2 Classification of ultrasonic energy losses in solids; outlining work undertaken at Brown Metals Research Laboratory

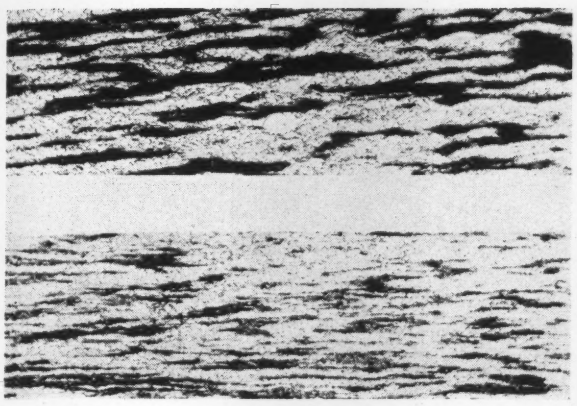


Fig. 3 Photomicrograph showing aging effect on chrome-nickel-moly test sample

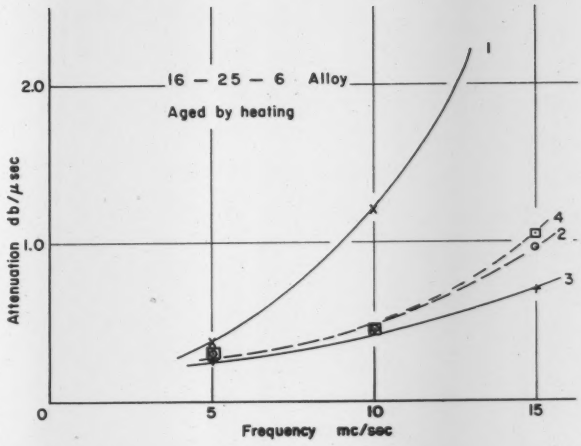


Fig. 4 Results of attenuation in the low megacycle region of chrome-nickel-moly specimens

aluminum alloy produces large changes in attenuation. In this case the fundamental behavior is understood much better than in the previous example.

In the internal-oxidation study, single crystals of copper with $^1/_2$ and 1 per cent of aluminum were heated in vacuum and then in oxygen and the ultrasonic attenuation of both longitudinal and transverse waves was examined over the frequency range from 10 to 75 mc/sec at various stages of the vacuum heat-treatment and oxidation. On heating in vacuum the attenuation generally decreases and on oxidation the attenuation increases by large amounts depending on how much of the sample actually is oxidized.

Fig. 5 is a cross section of a Cu Al specimen which has been internally oxidized as far into the sample as the sharp demarcation shown. Both regions are still single-crystal Cu Al.

Results similar to those obtained by the internal oxidation of Cu Al should be expected in a number of situations where aging and internal deterioration lead to precipitates or new phases interspersed in the original material.

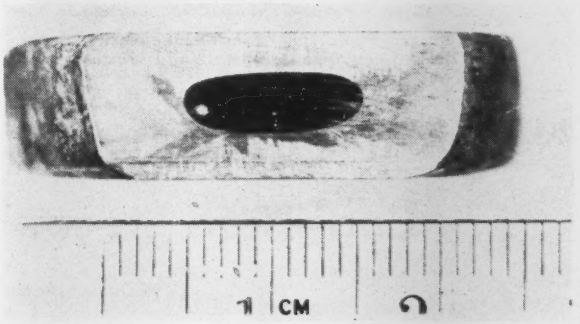


Fig. 5 Cross section of Cu-Al specimen which has been internally oxidized

Titanium-Hydrogen Experiment

In another set of experiments the introduction of hydrogen gas into titanium at elevated temperatures led to the formation of titanium hydrides which gave rise to large changes in ultrasonic attenuation. In the titanium-hydrogen experiments these attenuation changes were accompanied by large changes in ultrasonic velocity (as much as a 10 per cent change) which is unusual and interesting because it indicates a really drastic alteration in the material. Under these circumstances where the large attenuation and velocity changes occurred an appreciable part of the titanium had been converted to titanium hydride because large amounts of hydrogen had been taken up by the titanium.

Additional work is under way on this subject to determine how small an amount of hydrogen can be detected in titanium by this method.

A further example of the use of attenuation measurement as a tool in the study of the properties of materials is that of the examination of radiation damage in solids. When certain types of materials are exposed to neutron irradiation their physical properties change. In some materials the elastic constants may change by large amounts as well as the attenuation values. Semiconductor materials such as silicon exhibit large electrical and mechanical changes which are detectable by ultrasonic attenuation methods. A number of such studies in connection with radiation damage are now under way in our laboratory.

Numerous experiments also have been carried out on the plastic deformation of aluminum. The results show a surprising amount of detail in connection with "time effects" related to dislocation strain behavior.

Acknowledgments

The work described here has been done over a period of the past four or five years, and it represents the work and ideas of quite a few members and former members of the Metals Research Laboratory at Brown University. A proper acknowledgment to all concerned is not possible here. Most of the work described here has been supported financially by Army Ordnance through Watertown Arsenal and through the Office of Ordnance Research. We are particularly indebted to Mr. Carlton Hastings of Watertown Arsenal Laboratory for assistance and encouragement in this work. The work on semiconducting materials alluded to here has been supported by the U. S. Army Signal Corps.

Fig. 1 Prototype steam-turbine-electric locomotive constructed to determine suitability and economy of new type in Norfolk and Western service

Norfolk and Western

Coal-Fired Steam-Turbine-Electric Locomotive[1]

Construction and Test Program

The first part[2] is concerned principally with a description of the locomotive and its operation. The economic feasibility of the locomotive, which is interesting and important, is condensed in some detail. The balancing of higher first cost (as compared to reciprocating steam or diesel) plus a thermal efficiency, which is lower than diesel but higher than reciprocating steam, against the relative cost of coal and oil is a problem which can produce varying answers, depending on the assumptions made and who makes them. Under test conditions at the Baldwin plant, the contract over-all thermal efficiency of 12.1 per cent at the generator output was realized. The second part[3] deals with the road tests of the new locomotive. These tests were made (1) to verify the drawbar-pull curve established by the builders in the locomotive specifications and to establish tonnage ratings for the new locomotive, (2) to develop the operating costs of the locomotive in comparison with other locomotives, and (3) to gain experience and data that would lead to simplification and improved performance of future locomotives of this type.

From the Builder's Angle

THE coal-burning noncondensing steam-turbine-electric locomotive built for the Norfolk and Western was attractive to the railroad as a means of continuing the use of bituminous coal with fuel cost that gave promise of being equal to, or less than, other forms of motive power presently available.

Fig. 1 shows the completed locomotive and indicates clearly its rugged construction.

The elements of economy in fuel and water in this locomotive result from the efficiency of a water-tube boiler, automatically controlled, which produces steam at 600 psig and 900 F total temperature, while burning approxi-

[1] Based on two papers contributed by the Railroad Division and presented at the Annual Meeting, New York, N. Y., November 28–December 3, 1954, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS.

[2] Condensed from ASME Paper No. 54—A-185, "Coal-Fired Steam-Turbine-Electric Locomotive for Norfolk & Western Railway," by C. C. Hamilton, Research Engineer, The Babcock & Wilcox Company, Alliance, Ohio, Mem. ASME; P. D. Evans, Design Engineer, Steam Division, Westinghouse Electric Corporation, Lester, Pa., Mem. ASME; and R. P. Stoddart, Mechanical Engineer, Baldwin-Lima-Hamilton Corporation, Philadelphia, Pa.

[3] Condensed from ASME Paper No. 54—A-251, "Performance of Norfolk and Western Railway Company's Experimental Coal-Burning Steam Turbine-Electric Locomotive No. 2300," by I. N. Moseley, Research and Test Engineer, Norfolk & Western Rw., Roanoke, Va. Mem. ASME.

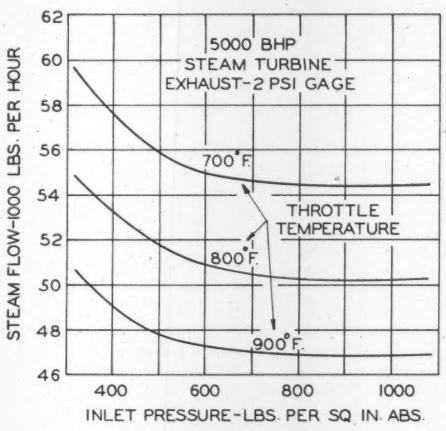


Fig. 2 Steam requirements of 5000-hp locomotive turbine over a considerable range of pressure and temperature

mately 100 lb of coal per sq ft of grate per hr; and a turbine which converts a substantial portion of the available heat to torque to drive a direct-current generator. Fig. 2 shows the steam consumption for a considerable range

Characteristics of N&W Locomotive

Wheel arrangement	6-6-6-6
Fuel	Bituminous coal
Steam conditions	600 psig 900 F
Fuel capacity of locomotive, tons	20
Water capacity of tender, gal	22000
Tractive effort (average with 25 per cent adhesion), lb	200000
Continuous tractive effort at 9 mph, lb	144000
Maximum speed, mph	60
Height, ft-in.	15-11 1/2
Wheelbase, ft-in.	
Rigid	13-0
Total locomotive	96-5 1/2
Total locomotive and tender	147-3 1/2
Length, ft-in.	
Locomotive (over couplers)	111-7 1/2
Tender (over couplers)	49-6
Total locomotive and tender	161-1 1/2
Maximum curves, deg	18
Weights, lb	With coal
Per axle—front trucks	68833
Per axle—back trucks	67500
Total locomotive	818000
Weights, lb	Without coal
Per axle—front trucks	62167
Per axle—back trucks	67500
Total locomotive	778000
Weight—tender (loaded)	365000
Service	Freight

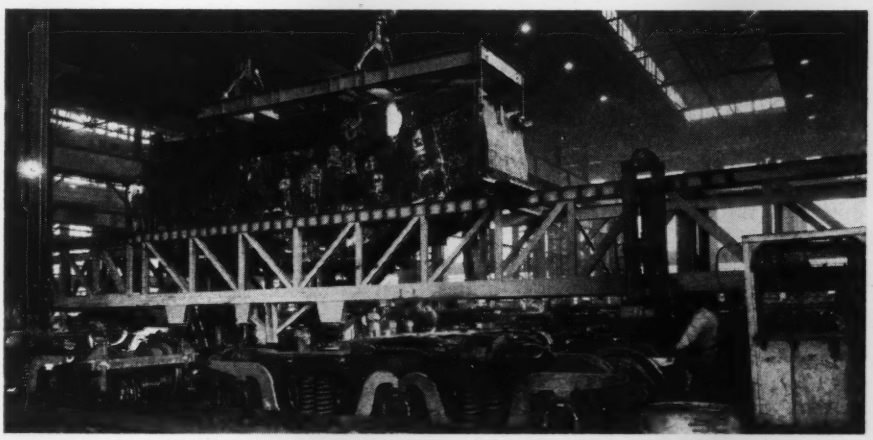


Fig. 3 View during shop assembly of boiler being lowered into frame

Fig. 4 Superstructure having been erected, turbogenerator is being lowered into place on its foundation

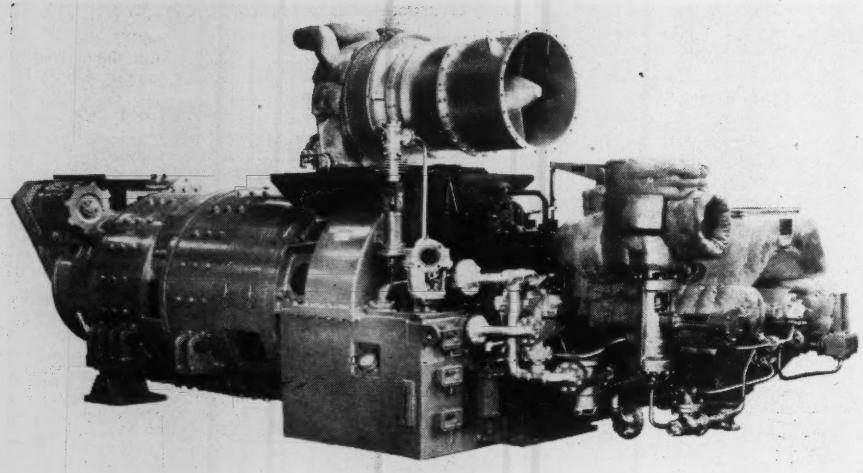


Fig. 5 Locomotive turbogenerator is a single assembly consisting of steam turbine, reduction gear, and double-armature generator

of pressure and temperature. The gain from increased pressure would be slight and would hardly warrant the extra weight and cost of equipment involved. For this locomotive the superheat temperature of 900 F and the noncondensing cycle were chosen to simplify the design and to avoid the use of high-alloy steels. Now that the operating problems of the present noncondensing plant have been overcome, means are being studied for using increased superheat and lower back pressure.

Twelve direct-current axle-hung traction motors provide the well-known flexibility of electric drive and utilize all of the locomotive weight for traction. Full horsepower is delivered through most of the normal operating speed range.

Builders

The design, development, and construction of this locomotive were undertaken by the following:

Norfolk and Western Railway—the customer and potential operator.

The Baldwin Locomotive Works (now Baldwin-Lima-Hamilton Corporation)—locomotive builder and prime contractor. This company was responsible for the mechanical portion of the locomotive, the tender, the installation of equipment, and the standing thermal-efficiency tests.

The Babcock & Wilcox Company—builder of boilers and component equipment, which, with Bailey Meter Company, assumed responsibility for the boilers, boiler-feed and coal-handling equipment and their control, and testing prior to installation in the locomotive.

Westinghouse Electric Corporation—builder of the turbogenerator, the electric equipment, and its control.

At the time the four companies initiated this project, numerous discussions were held regarding efficiency, economic feasibility, steam consumption of turbine and auxiliaries, wheel arrangements and weights, dependability of equipment, and the like. Discussions led to a two-stage program involving design and production:

1 Boiler to be designed, built, and tested. During this period the propulsion equipment would be designed and locomotive arrangement, in preliminary form, would keep pace with the equipment development.

2 When the boiler was tested and proved satisfactory for service to the four parties involved, the detail design and production of the entire locomotive was to proceed.

Step 1 began early in 1949, and Step 2 in June, 1951, after which thermal-efficiency tests on the completed locomotive were run at the Baldwin plant and the locomotive delivered to the Railway in May, 1954.

Locomotive Arrangement

The locomotive has a 6-6-6-6 wheel arrangement. Four 6-wheel swivel trucks are identical and are the same as used on Baldwin diesel-electric locomotives.

The equipment arrangement is determined by the fact that the boiler must be suspended between the two sets of running gear. Certain equipment was placed ahead of the boiler in the following order: Forward electrical compartment, coal bunker, operator's cab.

While the weight distribution would have been improved if additional equipment could have been placed forward of the boiler, all of the following equipment is located to the rear of the boiler: Main turbine and generator, feedwater equipment, and the rear electrical compartment. Some ballast was added to the front end of the locomotive in order to have equal axle weights with the bunker half full of coal.

The forward electrical compartment contains a control cabinet for the six traction motors of the front running gear, also a dynamic-brake compartment and an axial-flow traction-motor blower. Duplicate equipment is carried in the rear electrical compartment and, in addition, a generator control cabinet.

The space under the side slope sheets of the coal bunker is utilized to house the steam-driven air compressors, the stoker engine, main air reservoirs, and batteries.

Brake equipment Schedule 24-RL, together with some portions of the Bailey control equipment, is housed under the operator's cab.

Sandboxes are arranged for filling through the roof, using the same facilities as for conventional steam locomotives.

Figs. 3 and 4 taken during assembly of the locomotive show some of the interesting details of design.

The tender carries 22,000 gal of water and the zeolite

water softener. The Railway standard design of trucks was used, and with slight modification the tender water-bottom cast-steel frame.

Boiler and Combustion Details

Type and Construction. The boiler, Fig. 6, is a special natural-circulation, water-tube, longitudinal-drum, low-head design. Cyclone steam separators in the boiler drum provide dry steam to the superheater and steam-free water to the generating tubes. All generating tubes extend between the top drum and a connected, closed circuit of bottom headers. The generating tubes form the boiler walls and arch, and also are arranged in the gas path as convection surface. A steel casing is attached to the outside of the wall tubes forming a gastight enclosure. External supply tubes connect between the boiler drum and lower headers to deliver the steam-free water from the cyclone separators. A submerged-type feed pipe is used to deliver feedwater from economizer to drum.

Tubes of 3 in., $2^1/_2$ in., and 1 in. OD are used to form the various boiler components. A superheater, economizer, and gas-air heater are incorporated for maximum extraction of heat from the products of combustion. The air is heated to 350 F at full load, and feedwater to about 250 F. Stack temperature is 350 F or less.

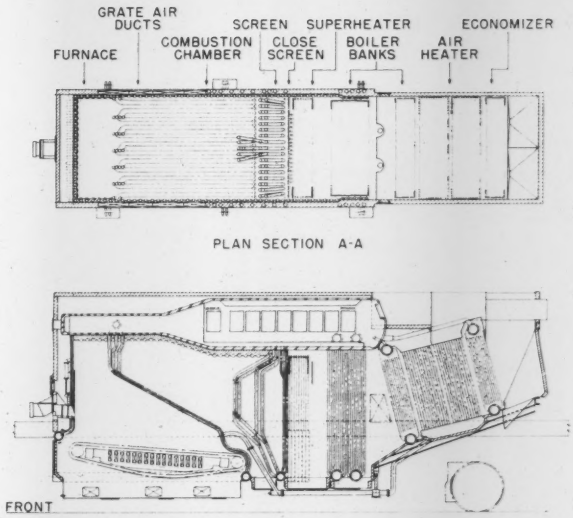


Fig. 6 Stoker-fired natural-circulation locomotive boiler

Coal Feed. Coal is delivered to the furnace by a modified type BK locomotive stoker. A forward-moving Rotograte, on which the coal is burned, continuously discharges ash at the firing end, moving at a speed of 9 to 10 fph. Discharged ash is distributed in the long flat ashpan by intermittent blowing of steam jets—electro-pneumatically timed. The conventional railroad-type steam-jet spreader stoker was chosen as a means of firing the boiler in order to minimize the problem of training crews and to utilize effectively the ability to bank the fire under waiting conditions but at the same time supply steam for the drive of the ever-needed air compressor. A natural-circulation boiler is essential for this type of firing if the high parasitic losses of turbine-driven auxiliaries, operating at low delivery conditions, are to be avoided, as the idling condition of this cycle, with all auxiliaries running, is substantial. Utilization of the natural-circulation boiler and a banked fire permit reducing this idling loss to that of the air compressor for periods of several hours, thus retaining a desirable feature of the conventional fire-tube boiler.

Fuel Combustion. Combustion air, supplied under pressure by a Westinghouse blower, flows through the two-pass gas-air heater and along each side of the drum to side-wall ducts in the furnace area. Air at the lower end of the side-wall ducts passes through ports between side-wall tubes to a wind box built within the Rotograte chain. Overfire air is admitted at the front wall in selected locations and through two cinder-return nozzles at the low end of the arch.

Boiler Controls. The boiler and its auxiliaries are controlled automatically by Bailey Meter pneumatic-type equipment. The control system is made up of standard components proved by long experience in stationary and marine practice. The system uses compressed air from the train-brake system with a small reservoir for instrument air storage. Air is reduced from 140 psi to 30 psi and filtered four times before entering any of the instruments.

Four instruments, called indicator controllers, are used for combustion and feedwater control. They measure (1) steam pressure, (2) steam flow, (3) drum water level, (4) air flow; and produce control air pressures proportional to the load. They control (*a*) stoker, (*b*) boiler blower, (*c*) feedwater, so as to maintain preset conditions of steam pressure, water level, and air flow.

The control system is centered in a console at the fireman's position in the cab. Here, hand-automatic selector valves are located for stoker, blower, feedwater, and water to heater. On-off cocks start and stop the stoker, feed pumps, stack jets, and rail washer. Push buttons are provided for low-water reset, emergency blowdown, and emergency boiler feed. Gages and indicators show pressures, drum and heater levels, and steam flow.

Turbogenerator

The locomotive turbogenerator shown in Fig. 5 is a single assembly consisting of a steam turbine, reduction gear, and a double-armature generator. A steam-turbine-driven blower supplying forced draft for the boiler is mounted on top of the gear case. The turbine is connected through a quill shaft to the pinion gear which drives the gear wheel and the directly coupled generator.

Steam Turbine. The steam turbine is of the noncondensing impulse type designed to operate with inlet-steam conditions of 600 psia and 900 F and atmospheric back pressure. Its rated capacity is 4500 hp input to the generator for traction plus approximately 200 hp for auxiliary power requirements. The noncondensing cycle was chosen in preference to a condensing cycle because it was concluded that for this initial locomotive the additional development, cost, size, and weight of a condenser were not warranted. The turbine normally operates at 8000 rpm at rated power output.

Reduction Gear. The reduction gear is of single helical type having an 8.9 to 1 ratio and delivers power to the generator shaft at 900 rpm under rated load conditions. A power take-off on the gear shaft drives the main oil pump and the governor. A 300-gal lube-oil reservoir is built into the lower portion of the gear housing.

Generator. The direct-current traction generator consists of two generators mounted back to back as a single

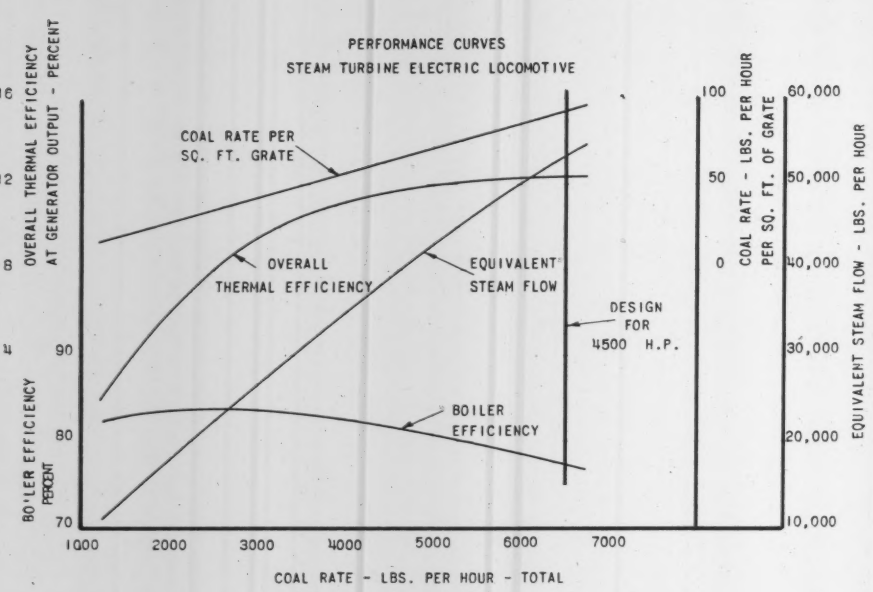

PERFORMANCE CURVES
STEAM TURBINE ELECTRIC LOCOMOTIVE
OVERALL THERMAL EFFICIENCY AT GENERATOR OUTPUT - PERCENT
BOILER EFFICIENCY PERCENT
COAL RATE - LBS. PER HOUR PER SQ. FT. OF GRATE
EQUIVALENT STEAM FLOW - LBS. PER HOUR
COAL RATE PER SQ. FT. GRATE
OVERALL THERMAL EFFICIENCY
EQUIVALENT STEAM FLOW
BOILER EFFICIENCY
DESIGN FOR 4500 H.P.
COAL RATE - LBS. PER HOUR - TOTAL

Fig. 7 Performance curves showing boiler efficiency, steam flow, thermal efficiency, and fuel rate

assembly. The two armatures are tandem-mounted on a common shaft and the stators are bolted together to form a common frame. The generator is self-ventilated by a fan mounted between the armatures. Cooling air is drawn in through both ends over the commutator brushes, then through the windings, and discharged through circumferential slots at the center of the frame. An alternator supplying power for the motor-driven traction-motor blowers is mounted on the outboard end of the generator with its stator bolted to the generator frame. The armature is carried on an extension of the main shaft. A sheave at the outboard end of the shaft extension provides a multiple vee-belt drive for an auxiliary generator and an exciter mounted on top of the alternator stator. The auxiliary generator provides power for battery charging, energizing the electrical control equipment and excitation of the alternator. The exciter provides excitation for the main-generator fields.

Traction Motors. Each of the twelve axles of the locomotive is motorized by a traction motor geared to it at a 15:63 ratio, of the same type as generally used for electric traction, and commonly called axle-hung, direct-current, series motors. Each motor is supported by axle bearings and a suspension pad on the truck. The three motors on each truck are series-connected. The motor groups on each of the front trucks are parallel-connected across the No. 1, and those on the rear trucks are similarly connected across the No. 2 generator during motorizing. The traction motors also are used to supply dynamic braking.

Control System

The turbogenerator control system is an embodiment of two separate but interrelated control systems—the turbine system and the electrical system. The turbine system is essentially hydraulic and responds to a pneumatic signal from the master controller at the engineman's control stand. It consists of a governor, speed changer, load limiter, and a servomotor for positioning steam-flow regulating valves in the turbine. The speed changer integrates the pneumatic "command" signal with a hydraulic-pressure signal from the speed-sensing governor and delivers a control pressure signal to the servomotor. A pressure-sensitive relay in the servomotor directs the flow of high-pressure oil to the servomotor piston which positions the steam-flow regulating valves in the turbine.

The function of the load limiter is twofold. It acts to prevent dangerous reduction of the boiler pressure and subsequent pull-over of water from the drum during transient-load changes, and it limits the maximum power delivered by the turbine for each notch position of the master controller.

The electrical control system is composed of a series of contactors, relays, and switches in both low and high-voltage circuits. The low-voltage circuits are principally control circuits regulated through the master controller to energize relay-operated switches in the high-voltage power circuits.

The engineman controls locomotive output from a conveniently arranged control stand which, in addition to the conventional air-brake pedestal, has the master controller and a five-position reversing lever which is used to select power or dynamic braking in either direction.

Protective Devices

The protective devices incorporated separately or as parts of the turbogenerator control system are too numerous to merit individual mention. Major devices, such as the turbine overspeed trip, emergency-brake power knockout, electrical rate of rise or surge relays and electrical ground relays, all act to stop the turbine completely and are automatic in operation. In addition, a manual trip for stopping the turbine in emergency is provided in the operating cab. All of these devices require manual resetting operations at the engineman's control stand before operation may be resumed.

Minor devices, such as the wheel-slip relays and dynamic-brake overcurrent relays, indicate a need for

reduction in power, which if unheeded, automatically reduce power but do not stop the turbine and require no resetting. Other minor devices give visual indication by lights on the engineman's control stand of low pressure and high temperature in the turbine lube-oil system, and failure of either or both of the traction-motor blowers to operate.

Performance

In tests at the builder's plant, the continuous rating of the locomotive was estimated as 144,000 lb at 9 mph at the rail.

Fig. 7 shows how certain factors vary with coal rate. The design point for 4500 hp is about 6500 lb of 13,500-Btu coal per hr. The best boiler efficiency of 83 per cent is at a slightly lower firing rate. The equivalent steam flow is arrived at by adding to the 600-psi 900 F steam the equivalent amount of such steam that could have been produced by the heat added to other steam and to the boiler blowdown.

Over-all thermal efficiency has a well-sustained high value. The fuel consumption at idling is about 14 to 15 per cent of that at full load. The coal rate per square foot of grate is a straight-line function of coal burned per hour divided by the grate area.

Heat Balance. Of the heat added in the boiler, i.e., the total heat of steam above feedwater temperature, about 16 to 18 per cent is required for auxiliaries and continuous blowdown at full load. The auxiliaries which exhaust into the feedwater heater provide about 13 to 14 per cent of the feedwater by volume.

The total heat value of coal fired at full load is about 87 $\times 10^6$ to 88 $\times 10^6$ Btu per hr. At a boiler efficiency of 77 per cent, about 67 $\times 10^6$ to 68 $\times 10^6$ Btu per hr is added to the water by the boiler. On an equated basis this would be an evaporation of 53,000 to 54,000 lb of water per hr to steam at 600 psig and 900 F total temperature.

Information as to dimensions, weights, and general characteristics is given in the Table of Characteristics. The locomotive and tender are of about the same length (161 ft, $1^1/_2$ in.) as a three-unit diesel-electric of similar power. The weight is more when the tender is included. The locomotive was designed for freight service and geared for 60 mph.

Special Features

This steam locomotive includes the combination of several features which, while proved satisfactory in Navy and stationary practice, are new to the locomotive field, and they have been incorporated for the first time in locomotive design in this unit. The high-pressure high-temperature water-tube boiler, with complete automatic control of fuel and air to the furnace as well as feedwater to the boiler in exact proportion to the demand for steam, and the self-cleaning traveling grate on which the coal is burned, are entirely new to locomotive practice. The use of the high-pressure high-temperature steam so produced in a turbine unit delivering 4500 hp to the electric generator supplying power for the traction motors, contributes to the high thermal efficiency of the over-all locomotive power plant.

Time and economic considerations will resolve the question as to whether this locomotive, or modifications of it, has a lasting place in the motive-power field.

Performance in Service

THE locomotive was shipped to the Railroad for road testing from the Baldwin-Lima-Hamilton Corporation's plant in Philadelphia on May 19, 1954. It was displayed at the Southern Appalachian Industrial Exhibit at Bluefield, W. Va., on May 26, 27, and 28, before being placed in service between Roanoke, Va., and Bluefield, W. Va., on June 1 for preliminary shakedown runs. During these preliminary runs the locomotive made approximately a round trip daily, a total of 200 miles.

Dynamometer Tests

Full-scale dynamometer tests were begun on July 19 and completed on October 2, 1954. The Norfolk and Western's dynamometer car was used in all tests to record drawbar pull, dynamic-braking effort, speed, time, location, and distance. Temporary plates were placed over the stoker trough in the coal bunker and all the coal burned was dumped from a weighing bucket into an exposed section of the trough in the operators' cab. The coal, which was double-screened 2 in. $\times$ $^1/_4$ in. high volatile, was weighed in 200-lb increments, using a balance scale. Representative coal samples were taken during each test and a proximate analysis was run on each sample. The water consumption of the locomotive was measured with the aid of calibration boards at the four corners of the main tender and the auxiliary tender. The auxiliary tender, with a capacity of 16,000 gal, was employed to eliminate water stops between terminals.

In the mountainous districts the new steam turbine-electric locomotive was compared with the Norfolk and Western's Class Y6b, a 2-8-8-2 mallet; and in the flat districts the new locomotive's performance was compared with that of the Norfolk and Western's Class A,

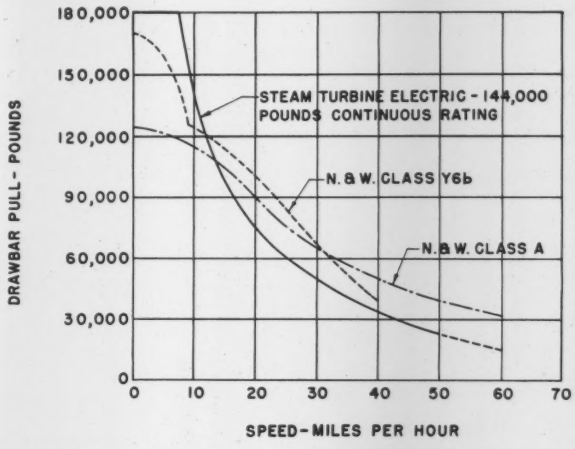


Fig. 8 Drawbar-pull curves for the steam turbine-electric locomotive compared with class Y6b and class A locomotives

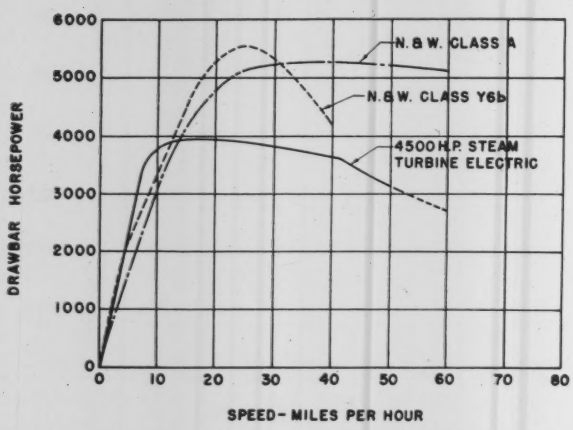


Fig. 9 Drawbar-horsepower curves for the steam-turbine-electric locomotive compared with class Y6b and class A locomotive

which is a 2-6-6-4, single-expansion, articulated locomotive. The drawbar-pull curves for the three locomotives are shown in Fig. 8. The steam-turbine locomotive has the highest drawbar pull of the three locomotives up to about 12 mph while the Class Y6b has a higher drawbar pull than the steam turbine at speeds above 12 mph. The Class A has a higher drawbar pull than the steam-turbine locomotive at speeds above about 13.5 mph. There is a drop in the turbine locomotive's drawbar pull at speeds above about 41.5 mph.

The turbine normally operates at constant horsepower and the speed of the turbine is controlled by the torque requirements of the generators up to the maximum turbine speed of 8000 rpm, which is controlled by the governor. The generators reach their maximum voltage after the last stage of field shunting has been made and the turbine has reached the maximum speed allowed by the governor. This point is reached at a locomotive speed of about 41.5 mph.

Fig. 9 shows the drawbar-horsepower curves for the three locomotives. These curves show, in a different form, the same general comparison of the three locomotives as the drawbar-pull curves. The steam-turbine-electric locomotive has the largest horsepower available at the drawbar up to about 12 mph; Class Y6b has the highest drawbar horsepower from 12 to 31 mph; and Class A has considerable advantage over the other two locomotives at speeds above 31 mph. The unloading of the steam turbine-electric at speeds above about 41.5 mph is more apparent in its drawbar-horsepower curve. This condition will be corrected on future locomotives.

Radford Division Tests

The tests were conducted on the Railroad's Radford, Pocahontas, and Scioto Divisions. The Radford Division extends from Roanoke, Va., to Bluefield, W. Va., a distance of 100 miles and crosses two mountain ranges. The ruling grade, westbound, is over the Allegheny Mountain Range between Elliston and Christiansburg, being 11.5 miles of 1.32 per cent grade, not compensated. From Walton to Glen Lyn, the railroad follows river grade along New River. The steepest grade on this division is the 3 miles of 1.60 per cent grade, not compensated, going into Bluefield.

The westbound tests on the Radford Division showed that, in day-to-day operation, the steam turbine-electric locomotive would be capable of handling 3600 tons of empty coal hoppers, Roanoke to Bluefield. During the tests the new locomotive handled a maximum of 161 empty coal hoppers with a total train tonnage of 4052 tons westbound over this division. The tonnage rating for the Norfolk and Western's Class Y6b locomotive, westbound on this division, is 3000 tons. The dynamic brake proved to be more than capable of holding the trains on the 1.00 per cent descending grade between Christiansburg and Walton without using the air brake.

During the eastbound tests on the Radford Division, the steam-turbine locomotive handled a maximum of 144 loaded coal hoppers with a total train weight of 13,073 tons. An eastbound tonnage rating of 11,500 tons has been established for the new locomotive. The present eastbound rating for the Class Y6b is 10,300 tons; both of these ratings include the use of a Class Y6 pusher over the 8-mile 1.00 per cent compensated grade from Walton to Christiansburg.

Fig. 10 is a graphic comparison of the fuel costs per thousand gross-ton-miles for the two locomotives when operating on the Radford District. The hatched bars show the fuel costs for the two locomotives when operating westbound, and the solid bars show the eastbound fuel costs.

Pocahontas Division Tests

The 100-mile-long Pocahontas Division is another mountainous division and extends from Bluefield to Williamson, W. Va. In the westbound tests on this division the steam-turbine-electric locomotive showed only a slight operating advantage over the Railroad's Class Y6b, since both locomotives can easily handle the relatively small coal movement from Bluefield to Kimball, where the trains are filled out to 175 loaded hopper cars. The remaining part of the run into Williamson is down-river grade along Tug River. The dynamic brake is responsible for the slight westbound operating advantage the turbine locomotive has over the Class Y6b on this division. The dynamic brake enabled operating crews to bring 5600 tons down the 1.4 per cent compensated grade from Elkhorn Tunnel to North Fork without the use of air-brake retaining valves on the cars.

The eastbound tests on the Pocahontas Division showed that the steam-turbine locomotive would be able to handle, in regular service, 8600 tons of loaded coal hoppers from Williamson to Farm, W. Va., and 4300 tons from Farm into Bluefield. The ruling grade from Williamson to Farm is the 4 miles of 0.6 per cent compensated grade between Wilmore and Roderfield. From Farm into Bluefield the $7\frac{1}{2}$ miles of 1.4 per cent compensated grade between North Fork and Elkhorn Tunnel is ruling. The present eastbound tonnage rating for the Class Y6b is 7200 tons between Williamson and Farm, and 3600 tons from Farm into Bluefield.

When handling the same tonnage as the Railroad's Class Y6b on the mountainous Radford and Pocahontas Divisions, the turbine locomotive made 4 to 13 per cent less speed, but showed a fuel saving of 20 to 30 per cent. In these two mountainous districts the steam-turbine-electric was able to handle between 18 and 27 per cent more tonnage, varying with the districts. With increased tonnage, the speed was 13 per cent less and fuel saving, based on cost per ton-mile, was 19 to 37 per cent.

Scioto Division Tests

On the Scioto Division the steam turbine-electric locomotive was tested and compared with the Railroad's Class A locomotive. The Kenova District extends from Williamson, W. Va., to Portsmouth, Ohio, a distance of 112 miles. The ruling grades on this district are at the approaches to the Ohio River Bridge at Kenova, the westbound ruling grade being $2^1/_2$ miles of 0.3 per cent compensated grade and the eastbound ruling grade being $^1/_2$ mile of 0.66 per cent grade.

Westbound, from Williamson to Portsmouth, the steam turbine-electric locomotive handled relatively the same tonnage as the Norfolk and Western's Class A, but at a lower speed; the average speed of the turbine locomotive was 13.3 per cent lower than the average speed of the Class A. In gross ton-miles per hour based on running time, the turbine-locomotive test runs averaged 11.1 per cent less than the runs with the Class A, but the cost of fuel per thousand gross ton-miles for the steam turbine-electric locomotive averaged 29.6 per cent less than for the Class A.

The eastbound test runs from Portsmouth to Williamson showed that the steam-turbine locomotive could handle the Railroad's maximum car limit of 175 empty coal hoppers, but again at a lower speed than the Class A. The turbine locomotive's average speed was 11.8 per cent lower than the Class A's average speed. In gross ton-miles per hour running time the turbine locomotive showed a deficit of 8.1 per cent in comparison with the Class A. However, the steam-turbine-electric locomotive's average fuel cost per thousand gross ton-miles during these eastbound runs was 29.9 per cent lower than the Class A's average fuel cost.

Fig. 11 is another bar graph showing the comparison of locomotive fuel costs per thousand gross ton-miles during the test runs on the Kenova District. The hatched bars show the fuel costs for the eastbound movement of empty coal hoppers, and solid bars show fuel costs for the westbound movement of loaded coal hoppers.

Operating Experience

No major difficulties have been experienced with the steam-turbine locomotive, although there have been some failures. These failures include a stopped-up stoker trough; broken flexible steam connections to the cold-water pump; failure of a traction motor blower-breaker; original main feed-pump governor of improper size; and difficulty with the main turbine controls. These minor troubles have been corrected.

As of October 30, 1954, the new locomotive had accumulated approximately 19,000 miles of service on the Norfolk and Western, and while it is too early to evaluate maintenance costs, routine maintenance has not been excessive. Adjustments to locomotive appurtenances, normally to be expected with a new type of locomotive, have been made during the tests. Electrical maintenance is comparable to that required on the diesel-electrics; turbine maintenance has amounted to monthly tightening of flanged connections; and boiler maintenance so far has been solely in conformation with ICC requirements. Monthly cleaning has constituted the maintenance on boiler controls. The zeolite water softener mounted on the tender is backwashed every 1000 miles and regenerated every 8000 miles. The operation of a fleet of these locomotives will permit the zeolite water softener to become a part of the terminal water-treatment plant.

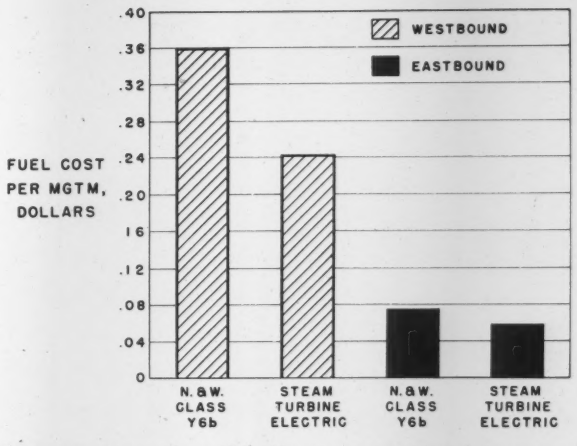


Fig. 10 Comparison of fuel costs per thousand gross-ton-miles for turbine-electric and class Y6b locomotives operating on Radford Division

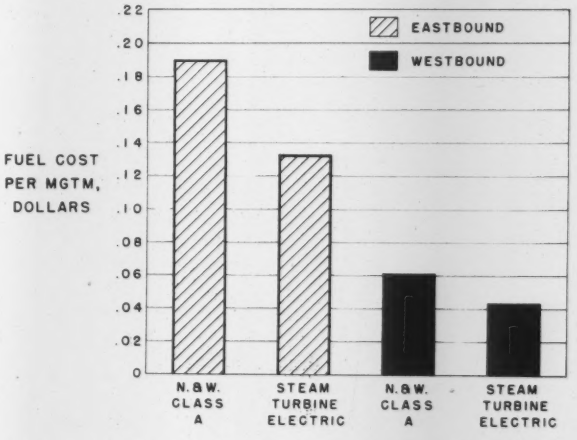


Fig. 11 Comparison of fuel costs per thousand gross-ton-miles for turbine-electric and class A locomotives operating on the Kenova District

Outlook for New-Type Locomotive

The coal-burning steam-turbine-electric locomotive has very definite promising possibilities. The ability of this 4500-hp locomotive to handle the same, or greater, tonnages as present locomotives, with fuel savings up to 30 per cent, at only a small increase in time start to stop, makes it so attractive as to be imperative that further study be given to improvements in design that are apparent. The first cost of locomotives of this type is not known at present. Simplification of controls and elimination of some protective devices already have been found possible.

The locomotive has been placed in pool service where its performance will be watched carefully while economic studies are being made.

At this time the future of this type locomotive is bright.

Briefing the Record

Abstracts and Comments Based on Current Periodicals and Events

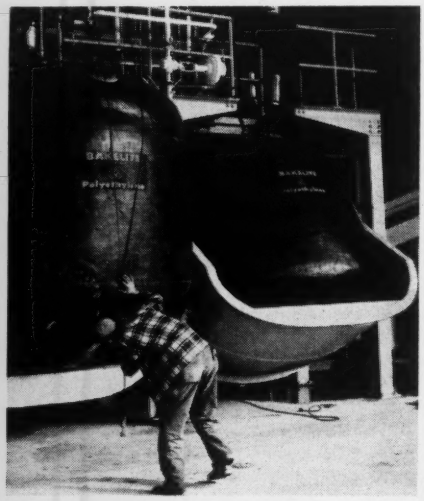
J. J. Jaklitsch, Jr., *Associate Editor*

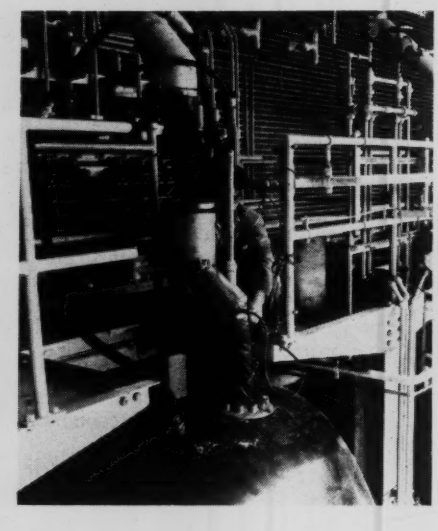
Synthetic-Rubber Containers

HUGE collapsible containers save an estimated one third of a cent a pound in bulk shipments of Bakelite polyethylene resins to Bakelite Company customers in lots of 9400 lb net per container. Made of synthetic rubber and fabric like 4-ply auto tires, the reusable containers are part of a new mechanical-handling system employed by Bakelite Company to reduce the customer's bulk-handling costs, resin losses, and storage space.

Fully enclosed from start to finish, this new system also helps to maintain final product quality by keeping out dust, dirt, and other contaminants. Nearly 8 ft high, the collapsible containers have loading capacity of 300 cu ft.

The containers were developed and are manufactured by the United States Rubber Company from polychloroprene rubber and fabric. Bakelite Company, a division of Union Carbide and Carbon Corporation, has adopted the costsaving new system to realize for





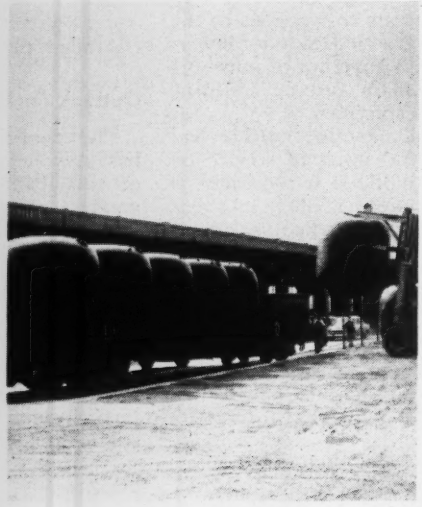


Fig. 1 Lift trucks pick up empty, collapsed containers at outdoor storage points (*top left photo*) and carry them to a specially designed unit that inflates, washes, and air-dries them. A light-duty monorail system moves the clean container to a filling cradle that tilts to a 45-deg angle (*top right photo*). At the container's true high point, its filling closure connects while under pressure with a filling spout through a special sleeve valve (*bottom left photo*). A rotary-vane resin disperser is lowered through the sleeve valve before the resins are poured into the container. Lift trucks carry filled containers to a weighing station and then to storage. The containers are designed in various sizes for loading on standard 52½-ft railroad gondola cars (*bottom right photo*).

itself and its customers the fullest benefits of process automation in bulk materials handling.

Unloading seven of the new collapsible containers from a railroad car takes about one-half hour as compared to an average 16 man-hours required to unload an equal volume of paper bags used for shipment of polyethylene resins. Each huge container replaces the handling of about 190 paper bags with one unit load. Adapted to mechanized-handling methods, these containers reduce the fabricator's manpower for receiving bulk shipments to a maximum of one operator. A series of field-trial shipments of Bakelite polyethylene resins between South Charleston, W. Va., and Ottawa, Ill., plants have been made.

Collapsing the flexible containers after use and storing them outdoors releases valuable warehouse space (currently estimated at 60 to 80 cents per sq ft per yr) for other uses. Maintenance cost for the system is expected to be low enough for the fabricator to gain an over-all profit in bulk-handling operations even though initial investment in equipment may range from about $15,000, to handle 250,000 lb per month, up to $40,000 for higher consumption rates. The resin producer assumes the major investment cost for the use of these lightweight and low-cost collapsible containers.

Airtight and moisture-resistant, the huge new containers need little or no surface preparation to protect them against weather. Their 4-ply construction provides strength to withstand high pressures and resist puncture as well as sunlight or grease, and yet remain pliable over a wide temperature range. Designed for use in standard bulk-transportation units, the big containers fit comfortably into railroad gondola cars and open-top truck trailers. Special handling equipment and mechanical devices have been designed for economical and contamination-free cleaning, inspection, filling, loading, transporting, and unloading.

The new handling system, now under test for other products, is considered desirable for food products and hygroscopic materials, such as calcium carbide, where contamination, air, or water must be excluded. Large-volume barge shipments of carbon black from production

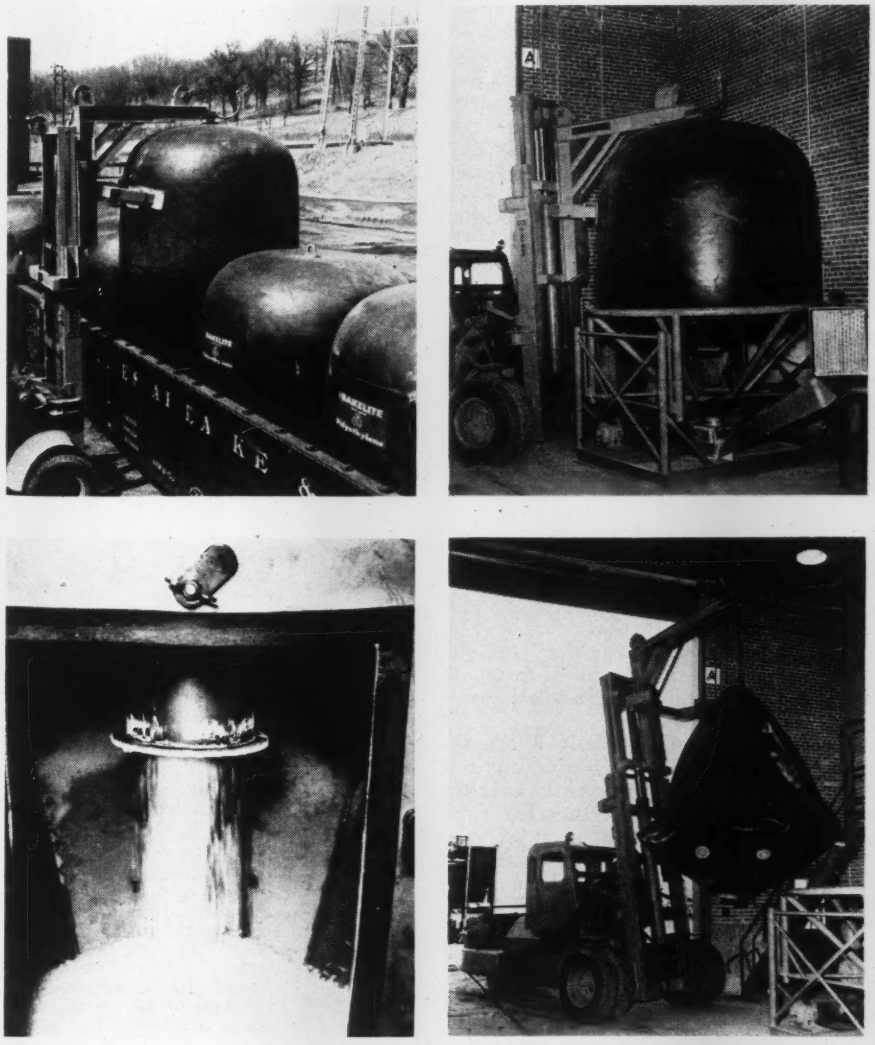


Fig. 2 The collapsible synthetic-rubber containers take about one-half hour to unload (*top left photo*). At the receiving end of field-trial shipments, lift trucks carry the containers to a specially designed emptying fixture (*top right photo*). A sleeve valve, similar to the one used for loading, connects to the container's closure. Bakelite polyethylene resins pour out of the container through the airtight system and are ready for processing (*bottom left photo*). The uncontaminated resin helps to maintain the customer's product quality and reduces rejects. When the container is empty, it is removed from the unloading fixture (*bottom right photo*), collapsed, folded, and returned to a storage area awaiting periodic shipment back to the resin producer for refilling.

plants in Texas to the tire industry indicate another major area of application for the new bulk-handling system.

High-Temperature Silicone Rubber

A NEW type of silicone rubber, capable of remaining flexible at 600 F, has been developed by General Electric Company's Silicone Products Department at Waterford, N. Y.

The materials, designated Class 700, have been designed to extend the application range of silicone rubber to 600 F. Although far superior to organic rubbers in high-temperature resistance, Silicone rubber has been hitherto limited to a maximum usable range of about 500 F.

The new materials are capable of remaining flexible for 150 hr or longer during continuous exposure up to the peak of the new temperature range, according to G-E engineers. Previously available types of silicone rubber became brittle in less than 24-hr exposure to this heat.

Applications anticipated for the new materials include kitchen oven-door seals and parts for hot materials-handling equipment in the glass, ceramics, and metals industry.

When used as kitchen oven-door seals, Class 700 silicone rubber is said to seal in heat as well as cooking odors, prevent staining of range-front surfaces, muffle door "clang," and is readily cleaned with soap and water. It contains rubberlike flexibility and usefulness even at highest oven-baking temperatures, G-E claims.

The improved extreme high-temperature resistance of the Class 700 materials has been obtained without sacrificing other outstanding silicone-rubber properties, such as ozone, aging and weathering resistance, low-temperature flexibility, and low-moisture absorption.

The designation Class 700 covers silicone-rubber compounds produced by G-E's Silicone Products Department, as well as stocks compounded from G-E silicone gums by rubber compounder-fabricators. Class 700 stocks are suitable for molding extrusion or calendering fabrication methods. One representative compound, designated SE-750A, is reported by G-E silicone engineers to be particularly suitable for the new hot-air technique of curing extruded parts.

Titanium Shear Bolts

TITANIUM shear bolts that equal or exceed present-day steel shear bolts, not only in shear-strength requirements but also in the critical factor of fatigue life, have been developed successfully by Standard Pressed Steel Company, Jenkintown, Pa.

The new titanium shear bolts follow the development earlier this year by SPS of a titanium tension bolt that poundwise is claimed to be twice as strong as steel tension bolts—a performance that has subsequently been confirmed by leading aviation test laboratories.

While titanium tension bolts are important in aircraft design, lightweight titanium shear bolts are even more vital to the weight-conscious aviation industry. The large majority of threaded aircraft fasteners are shear bolts—as much as 95 per cent of total bolt weight in some planes.

Size-for-size replacement of present-day steel shear bolts by the new SPS shear bolts, which weigh only 57 per cent as much, could cut as much as 500 to 1000 lb from the weight of the larger aircraft.

In announcing its new bolts, called Hi-Ti titanium shear bolts (Type NAS 464), SPS pointed out that the fasteners (1) will meet a new standard for titanium shear bolts now being developed by the aviation industry—that is, satisfactory performance under tension-fatigue loads; (2) are probably the first titanium shear bolts to come with a complete pedigree in fatigue; (3) have, pound for pound, as much as five times the fatigue strength in some sizes as comparable steel bolts now in use; and (4) are, surprisingly enough for shear bolts, in some sizes as strong in tension fatigue as high-strength steel and titanium tension bolts.

In announcing the Hi-Ti shear bolt, SPS published complete tension-tension fatigue data for both $^1/_4$-in. and $^1/_2$-in-diam bolt sizes.

Pound for pound, the $^1/_4$-in. Hi-Ti shear bolts proved to have more than five times the endurance strength of comparable $^1/_4$-in. steel bolts.

The endurance strength is the maximum load that can be applied repeatedly without inducing failure. It is arbitrarily determined by stressing the bolt for 8,000,000 load cycles. Under these conditions, the $^1/_4$-in. Hi-Ti bolt withstood a load of 60,000 psi, the $^1/_4$-in. steel bolt, a load of 20,000 psi. When the relative weights of the two metals are considered, the strength-to-weight ratio in fatigue of the $^1/_4$-in. titanium bolt comes out to more than five times that of the steel bolt.

Fatigue tests of the $^1/_2$-in. steel and titanium shear bolts showed that both had an endurance strength of

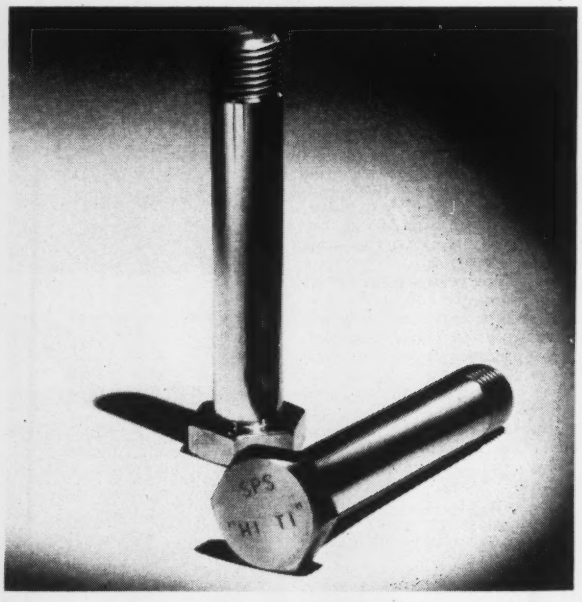


Fig. 3 Hi-Ti titanium shear bolts, equal to or better than comparable steel bolts, are Standard Pressed Steel Company's latest solution to the problem of putting lightweight titanium to work in critical aircraft applications. Since the bulk of threaded aircraft fasteners are shear bolts the new Hi-Ti bolts could cut as much as 1000 lb from the weight of the largest aircraft. Each pound of titanium bolts that is substituted for equivalent-size bolts saves three quarters of a pound of total weight. The new shear bolts, like the Hi-Ti titanium tension bolts, are outgrowths of a company-sponsored, $500,000 titanium research program.

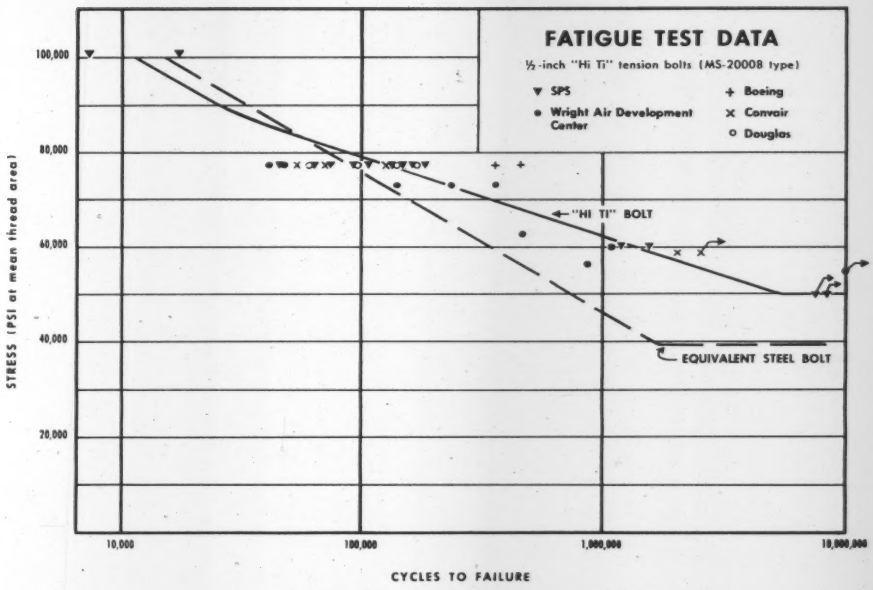


Fig. 4 Chart shows how tension-tension fatigue tests conducted by SPS on its earlier Hi-Ti titanium tension bolt have been closely approximated in independent tests conducted by four other laboratories. Solid line and triangular points are the data on $^1/_2$-in. Hi-Ti tension bolts published by SPS earlier this year. Each symbol on the chart represents one Hi-Ti tension bolt tested. Symbols with arrows indicate that test was completed without bolt failure. Dotted line represents tension-tension fatigue performance of comparable $^1/_2$-in. steel bolt. Point at extreme right of chart, representing test of Hi-Ti bolt to 10,000,000 load cycles, indicates an even greater endurance strength for the $^1/_2$-in. Hi-Ti tension bolt than the value of 50,000 psi previously determined by SPS. On the basis of an endurance strength of 50,000 psi as compared to 40,000 psi for the steel bolt, the $^1/_2$-in. titanium tension bolts have an endurance strength—pound for pound—more than twice that of steel bolts.

30,000 psi. On a strength-to-weight basis, therefore, the titanium shear bolt is 75 per cent better than the steel bolt in fatigue.

In shear-strength tests, both Hi-Ti shear bolts far exceeded the minimum shear requirements—95,000 psi—for present-day steel aircraft bolts. The $^1/_4$-in. Hi-Ti bolt had a shear strength of 109,200 psi, the $^1/_2$-in. Hi-Ti bolt, a shear strength of 112,000 psi. Both values were comparable to the shear strengths of the equivalent steel bolts tested. On a weight basis, however, a Hi-Ti shear-bolt strength is more than 60 per cent greater than that of the steel bolts.

SPS's emphasis on tension-fatigue performance underscores the importance of this new standard for judging titanium shear bolts.

Main criterion for a steel shear bolt has been its ability to withstand a shear or cutting force across the shank of the bolt. This is the main structural load encountered by this type of bolt in aircraft applications.

But in most shear applications there is some tensile loading or pull induced in a shear bolt. This has not proved to be significant in designing with steel shear bolts. But because of notch sensitivity, even mild tensile loading is a critical factor when using titanium bolts.

Titanium parts are greatly weakened by minute surface irregularities or notches—out of all proportion to the magnitude of the notch. Repeated tensile loads applied to incorrectly processed titanium fasteners can induce rapid fatigue failure.

Aware of this destructive effect of fatigue, leading aircraft companies like Boeing, Martin, Northrop, and Consolidated Vultee are now preparing specifications for titanium shear bolts that will require, for the first time, a minimum performance in tension fatigue as well as in shear.

Fatigue performance of the Hi-Ti shear bolts tested far exceeds the requirements now being proposed by these aircraft companies.

SPS has just published its own specification for titanium shear bolts (Type NAS 464) based on the company's more than 30 months of experience in the fabrication and testing of the lightweight metal.

While publishing data on $^1/_4$-in. and $^1/_2$-in. sizes, SPS reported that it is prepared to produce in quantity titanium shear bolts with properties equal to, or better than, equivalent steel bolts in sizes ranging from No. 10 up through $^1/_2$-in. diameter. The company is now testing out larger-diameter Hi-Ti shear bolts with favorable results.

Synthetic Cutting Fluid

Tool life in machining titanium metal with a synthetic, water-soluble cutting fluid increases as much as 300 to 500 per cent as compared to tool life with heavy-duty solubilized oils, according to experimental results released by Carbide and Carbon Chemicals Company, a Division of Union Carbide and Carbon Corporation. In comprehensive tests conducted by an independent or-

ganization, Ucon Cutting Fluid H-660 in a 1 to 5 dilution with water gave these results in turning and parting Ti 150 titanium test rings with No. 883 Carboloy carbide-tip tools.

Studies on friction between sliding metal surfaces show that in the case of titanium the coefficient of friction for Ucon Cutting Fluid H-660 and other Ucon synthetic lubricants is significantly lower than for conventional cutting fluids.

Ucon Cutting Fluid H-660 forms a clear solution with all proportions of water at room temperature. Its true water-solubility permits excellent visibility of the work being cut, formed, or ground. Then it can be completely removed with a cold-water rinse. The fluid can also be vaporized in heat-treating operations.

This synthetic fluid has been particularly effective in many machining, cutting, forming, and grinding operations on carbon steels, stainless steels, chrome-molybdenum and vanadium steels, and Nitralloy. Nonferrous metals being worked with this fluid include Inconel, Monel, aluminum and its alloys, phosphor bronze, beryllium copper, silicon brass, Stellite alloy No. 3, and Hastelloy alloys B, C, and D. It has been used with excellent results in grinding boron carbide and other hard, mineral-like materials.

High-Temperature Aluminum Alloy

THE thermal barrier that threatens continued use of aluminum alloys in supersonic aircraft has been partially lifted by a new experimental alloy, X2219, developed and patented by Aluminum Company of America's Aluminum Research Laboratories.

In the past, aluminum has not had sufficient heat resistance for use in many aircraft-engine applications and in proposed very high-speed aircraft structural components. Alcoa alloy X2219, with excellent properties for extrusions and forgings at elevated temperatures between 500 and 600 F, is the first step in lifting this thermal barrier.

Alloy X2219 is a member of the aluminum-copper group of aluminum alloys containing small additions of several other elements. In the solution heat-treated and aged condition, X2219 has exceptionally good mechanical properties, tensile and yield strength, and resistance to creep, at elevated temperatures in the range 500 to 600 F. The properties of X2219 will be of interest wherever increased strength at these temperatures is desired.

Mechanical Properties

Typical mechanical properties of X2219 for various exposures at elevated temperatures, 500 and 600 F, are given in Table 1. The mechanical properties of X2218, a standard forging alloy used extensively for elevated temperature applications, are included for purposes of comparison.

The typical elevated-temperature results tabulated in Table 1 are average values obtained by Aluminum Research Laboratories from a number of lots of material in each alloy. While these data are in some cases limited, values are believed to be representative of the alloys and accurately reflect relative strengths at each of the temperatures indicated. While the bulk of test data for X2219 was obtained from forged specimens, tests and experience on other alloys indicate that these properties are also typical of rolled or extruded products.

Table 1 Typical Mechanical Properties of X2219 and X2218 Alloys at Elevated Temperatures

		X2219-T6			X2218-T61		
Temp of test	Time at temp, hr	Tensile strength, psi	Yield strength, psi	Elong, % in 4D	Tensile strength, psi	Yield strength, psi	Elong, % in 4D
550 F	1000	29000	21000	24	13000	9000	50
600 F	1000	18000	14000	26	6000	3500	75
Stress for 0.2% total creep in 100 hr at 600 F, psi			6700			2300	
Stress for rupture in 100 hr at 600 F, psi			9500			3900	
Fatigue strength—10-8 cycles at 600 F, psi			5500			5000	

While X2219 alloy will be of interest principally because of elevated-temperature properties, tentative guaranteed minimum mechanical properties at room temperature have been established for acceptance purposes. These minimum properties, together with typical room-temperature properties, are given in Table 2.

Table 2 Minimum Mechanical Properties at Room Temperature

	Tentative guaranteed min	Typical
Tensile strength, psi	55000	62000
Yield strength, psi	35000	43000
Elongation, % in 4D	6	16

These minimum and typical properties are applicable to rolled and extruded shapes up to 4 in. thick, to separately forged test specimens, and to die forgings up to 4 in. thick when the axis of the test specimen is substantially parallel to forging flow lines and parallel to the parting plane.

Physical Properties

The physical properties of X2219 alloy are given in Table 3.

Table 3 Physical Properties of X2219 Aluminum Alloy

Alloy	Weight lb per cu in.	Electrical conductivity, % IACS	Thermal conductivity, C.G.S. units	Coefficient of thermal expansion per deg F × 10⁻⁶ Temperature range 68–212	68–392	68–572
X2219-0	0.102	44	0.41	12.4	13.1	13.6
X2219-T6	0.102	32	0.30			

Heat-Treatment

Alcoa alloy X2219 is being offered in the -T6 condition produced by a solution heat-treatment and water quench, followed by an artificial aging treatment. The -T6 temper provides the best strength for X2219 at 600 F.

Applications

Applications where the new alloy shows exceptional promise are in aircraft and automotive-engine parts where temperatures reach 500 to 600 F. Both gas-

turbine and reciprocating-piston engines require aluminum parts for that temperature range. Aircraft structural parts operating close to engines will be another application.

Use of X2219 is not restricted to aircraft and automotive applications alone. It should find use in fittings for pressure vessels and pumps and in many other parts subject to elevated temperatures.

Machinery Control System

A CONTROL system with no moving parts, which directs the operation of complex machinery, has been developed by Westinghouse Electric Corporation as "a major step toward completely automatic manufacturing processes and operations."

The new control system called a Cypak system was described recently by Westinghouse executives at a press conference in the Hotel Astor, New York, N. Y.

The basic components of the Cypak system are special magnetic amplifiers and transistors. Because these devices have no moving parts, the director system has "built-in" reliability—a key factor in the design of completely automatic processes and operations.

Cypak systems have been built and tested in a number of operations, it was pointed out. These include the control of a fully automatic six-story elevator; a supervisory control system for remote operation of electric-power systems; a relatively simple punch-press control, and a much more complicated spiral milling-machine control; a system for the selective delivery and removal of ingots from a soaking pit; a skip-hoist director which permits the automatic charging of a blast furnace according to a program selected by the operator; and a control for an automatic welder.

In the case of the automatic welder, which was installed several months ago, over one quarter of a million welding operations have been made to date under the control of the Cypak system. It was pointed out, however, that these test control systems do not indicate the limit of possible applications.

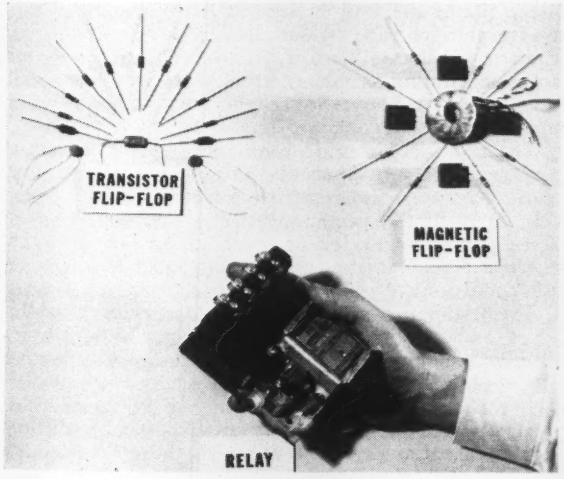


Fig. 5 High-quality relay is shown in *center;* components for a transistor flip-flop element are shown at *left;* and components for a magnetic flip-flop element are shown on *right.* The flip-flop elements perform the unlimited time functions.

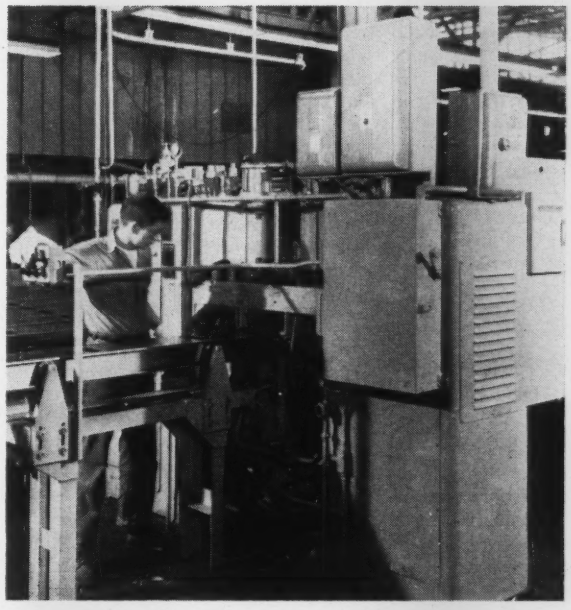


Fig. 6 The automatic bus-duct welder. The control cabinets are seen on the right of the welder with the Cypak system above and the relay control below.

A Cypak system might range in size from a unit as big as a table radio to a control panel the size of an upright piano, or larger, depending upon the complexity of the job it has to do.

In its present form, the basic "building block" of the system, when made with magnetic amplifiers, is flat, about 5 in. sq and about $1/2$ in. thick. One or two magnetic cores, looking like small doughnuts, are mounted on the flat square piece of insulating material.

The magnetic cores are wired in proper circuitry with the necessary resistors—which retard the flow of current—and capacitors—which store the current. The arrangement of various electrical connections determines what operation the unit will perform. A unit made with transistors looks like a small metal box with prongs, such as are found on an electronic tube.

Functions performed by these basic building blocks are known to the engineer as "and," "or," "not," and "time" functions. To the engineer, the "and" unit signals the performance of an operation only when all of a given number of signals are fed into it. For example, if applied to a machining operation requiring that three dimensions of a part be checked, the "and" unit would pass the part along to another operation only if dimensions "a" and "b" and "c" were within the necessary tolerances.

A unit with the "or" function delivers a job-performing signal when any one of a number of signals are fed into it. Hence, signal "a" or "b" or "c," etc., will result in the desired output signal. For example, an automatic elevator on the first floor of a building will go into operation when it receives a call from the third floor or the fifth floor, or the sixth, or eighth, or ninth, and so on.

The "not" function may be explained this way: As long as no signal is fed into it, the "not" unit will

continue to deliver an output signal. If, however, a signal is fed into the unit, no output signal will be delivered. An electric lock which stays "locked" while the current is on provides a simple example of the "not" function. If the electric current is cut off by pushing a button, the lock will open. Turning on the current by resetting the button will close the lock.

The building block with the "time" function in it would deliver a signal for a specified period or would delay the signal until a specified period of time had passed. It is simply a device with a "memory" which retains a job-performing signal until another signal comes along to "erase" it.

Automatic Screw Machine

A NEW No. 00 automatic screw machine said to be the fastest automatic in its range, was announced recently by Brown & Sharpe Manufacturing Company, Providence, R. I. Taking stock up to $^1/_2$ in. with 1 in. turning length (to $1^1/_2$ in. with special equipment), and maximum spindle speed of 7200 rpm, it gives increased production on all materials from free-cutting plastics to tough alloy steels. Parts can be machined to closer tolerances than has been possible on an automatic screw machine heretofore. Because of its rigid construction, carbide tooling can be used to excellent advantage on many jobs.

Push-button control and other features materially shorten setup time and reduce operator supervision while a job is in progress. Cross slides and detachable ways of hardened ground steel, precision ball bearings in spindle and sprockets, and fully automatic lubrication reduce maintenance problems to a minimum.

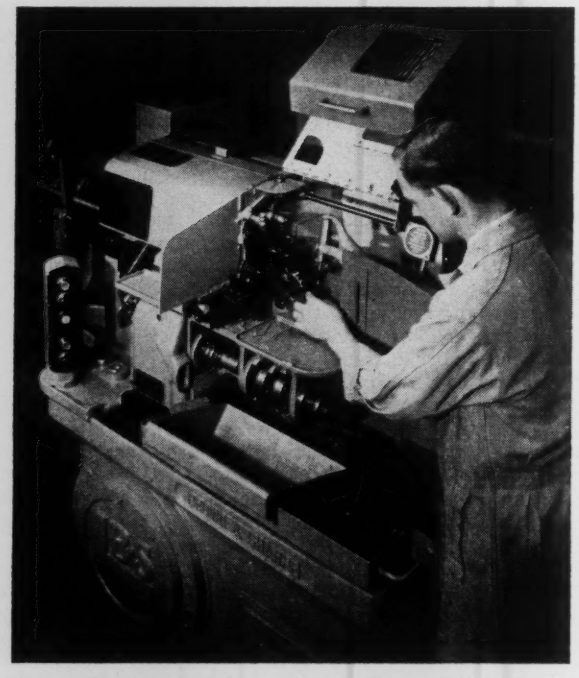


Fig. 7 Operator is shown setting up Brown & Sharpe's new No. 00 automatic screw machine

The vertical slide is standard equipment, permitting an additional tool position.

Spindle-speed range from 7200 to 34 rpm, with 208 combinations of high and low speeds in ratios from 2.3:1 to 16:1, permits high cutting efficiency on the widest variety of materials and work diameters. Selection of speeds and direction are made by simple pick-off gears. Positive chain drive of the spindle at all speeds assures adequate power throughout the full speed range.

A conveniently located control post provides push-button control of both spindle and driveshaft. A driveshaft "jog" button is particularly useful when setting up. The speed of the driveshaft (either 240 or 120 rpm), which drives all of the automatic mechanisms, is changed by transposing two pick-off gears—all belts are eliminated—and a safety device prevents rotation in the wrong direction. Eleven change gears give the complete range of 120 production rates from $^3/_4$ to 100 sec per piece.

Many conveniences and safety features are incorporated in the machine. The driveshaft handwheel does not rotate when the machine is in operation and moves out of the way with the compartment door when gears are changed. The automatically lubricated turret slide has a hand lever for convenience when setting up. The coolant supply is constant at both driveshaft speeds and excellent guarding with windows is provided around the work area. The large-capacity chip tray is removed readily and a wide trough facilitates raking out chips while the machine is running. Electrical controls conform to J.I.C. standards.

In addition to the many attachments available for previous Brown & Sharpe automatics, two new attachments have been added for the new No. 00. These are the skip indexing attachment, giving greatly increased production on deep-drilling operations, and brake in neutral permitting the use of both high and low speeds on those jobs where provision must be made to automatically stop the spindle.

Electronic Machinability Computer

AN electronic machinability computer that promises to make life of the tool engineer a little less complicated was revealed recently by Carboloy Department of General Electric Company, Detroit, Mich. The computer will solve machining problems, it is said, which normally take him several hours to compute, in less than two minutes with consistent and reasonable accuracy.

The new "engineering tool" will enable a methods and service man to determine quickly whether or not he is using a correct set of conditions for machining a current job; help him arrive at a proper set of conditions for setting up a new machining operation, or indicate to him the relative advantages of changing some of the present job conditions to obtain greater production.

The 32-lb self-powered analog unit measures 21 × 7 × 20 in. and will consider 14 operational variables in machining, such as grade of carbide, speed, feed, depth of cut, tool life, alloy, material hardness, etc.

It can be fed information on any of 13 variables and come up with the 14th, or the answer. It also will consider five variables which affect the motor horsepower required to do a machining job, coming up with the answer after being fed with information on four of the variables.

Answers provided by the computer are based on the use

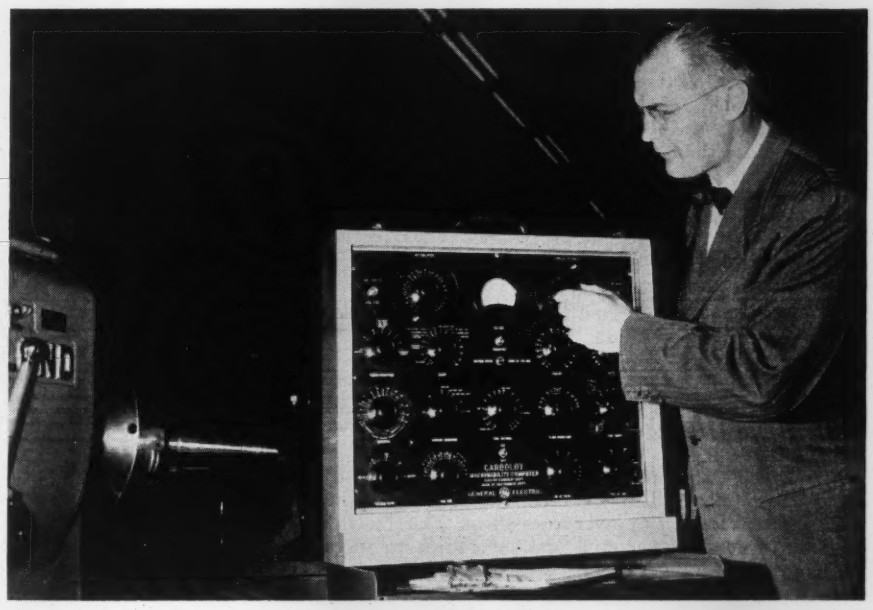


Fig. 8 Dr. W. W. Gilbert, Mem. ASME, who developed the new machinability computer, revealed recently by Carboloy Department of General Electric Company, Detroit, is shown here working out a typical problem

of those feeds, depths of cut, proper grades of carbide, and tool geometry which will result in a normal-wear-type cutting-edge failure.

The computer was developed by Dr. W. W. Gilbert, Mem. ASME, of G-E's Manufacturing Services Division, Schenectady, N. Y., after correlating basic data largely from General Electric experience in machining. The unit has been field-tested for more than a year in G-E operating components.

The new computer, to sell for approximately $500, will be manufactured for Carboloy Department by G-E's Instrument Department. Sales will be made by Carboloy exclusively. The unit will be available after September 1, and Carboloy is currently accepting orders.

Each computer will be registered and Carboloy will periodically update users with the latest machinability data.

Flame-Spray Ceramics

A NOVEL process for coating a wide variety of substances—by feeding powdered ceramic materials through a simple flame gun—has been developed at Armour Research Foundation of Illinois Institute of Technology, Chicago, Ill.

Coatings resulting from the process—called "Flame-Spray Ceramics"—are said to be superior to those produced by the metallizing processes because of their greater resistance to heat and chemical stability.

The technique of application is similar to that required for the metallizing processes. Flame-Spray Ceramics are sintered layers of refractory and chemically inert materials, such as aluminum oxide or zirconium oxide.

The spray coatings do not require that the metal or other base be heated unduly—as opposed to ordinary ceramic coatings which require heating both metal and ceramic to high temperatures.

Since the two basic Flame-Spray-Ceramic coatings—aluminum oxide and zirconium oxide—are stable metal oxides, they cannot oxidize further.

The alumina coating is harder than tool steel and unusually adherent in thicknesses up to about 10 mils. If applied more heavily, residual stresses may cause coating failure on sudden heating or cooling.

The coating appears to be extremely effective for protecting metals, such as steel and even aluminum, against high-temperature erosion such as that encountered in rocket nozzles.

The hardness of the coating suggests its use for protecting soft metals—aluminum, die-cast alloys, or mild steel—against erosion and abrasion in pump impellers and housings, fan blades and turbines, and piping subject to cavitation.

The alumina coating is electrically insulative and its use is anticipated in the manufacture of high-temperature process equipment. The coating is poorly wetted by certain molten metals, and preliminary tests show it to act as a satisfactory permanent mold coating for aluminum casting.

Like all sprayed coatings, Flame-Spray Ceramics have a residual porosity of about 10 to 15 per cent and, alone, do not provide perfect protection against chemical corrosion of the underlying material.

However, various additives to the two basic coatings improve their protective action, and this can be improved further by overcoating with recent ARF-developed "Solution Ceramics," or by cospraying with soft metals.

Transistorized Automobile Radio

DETAILS of an experimental transistorized automobile radio that operates directly from a 6-volt car battery and requires only about one tenth of the power used by a conventional car radio were given recently by scientists of the Radio Corporation of America. Facts about the new receiver were disclosed at a meeting of the Southern District, American Institute of Electrical Engineers, by

Larry A. Freedman, Thomas O. Stanley, and David D. Holmes, of the David Sarnoff Research Center of RCA, Princeton, N. J.

Employing nine transistors in place of electron tubes, the new radio is said to be equal in performance to standard car radios, the RCA scientists said. They pointed out that more than half the small amount of current required by the radio is used to light the two small pilot lights that illuminate its dial. A radio of this type, they said, would create so little drain on a car battery that it could eliminate many cases of battery failure that now occur when a driver forgets to turn off the radio when he parks his car.

The radio has been tested at Princeton with a 6-volt battery as its power source. It is also adaptable to installation in automobiles with 12-volt batteries, the RCA team said. With a 12-volt power supply, they added, the power output of the radio would be more than doubled, since it is not limited by the capabilities of the transistors.

While the experimental radio resembles present car radios in its external appearance, the scientists said, it requires no vibrator, power transformer, or rectifier—elements needed in vacuum-tube car radios to increase and control the power level.

They also emphasized that the transistorized radio maintains a high level of performance over the widest range of temperatures likely to be encountered in automobile service. In laboratory tests, it has performed satisfactorily at temperatures as low as —40 F and as high as 176 F, they said.

New Steel Process

Steel ingots are now being heated by electric induction at Western Canada Steel's Vancouver Rolling Mills in British Columbia. It is said to be the first such installation.

The new process, it is claimed, cuts the time for heating steel ingots by approximately 75 per cent, increases production 30 per cent, and reduces fuel costs by one dollar a ton or approximately $100 a shift.

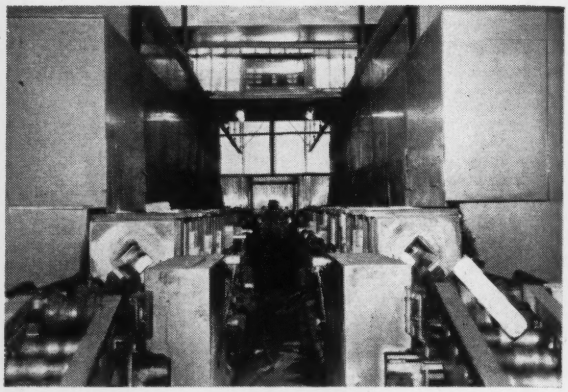


Fig. 10 It takes 60,000 volts of electric power to provide the 10,000 hp energy of this giant twin-tube electric induction-heating unit at Western Canada Steel's Vancouver Rolling Mills, Vancouver, B. C., Canada.

Where it took about 45 min to heat the ingots in the oil-fired furnaces which were used previously, it only takes from 8 to 12 min to get them red-hot in the new twin-tube electric induction-heating unit.

The furnaces have a total capacity of 10,000 hp, and a direct line from the B. C. Electric Company's Kidd Substation feeds in 60,000 volts to provide this energy. Counting their operation at Vancouver Steel Company Ltd., where molten steel is poured into ingots, Western Canada Steel now uses 4,000,000 kwhr of electricity in a single month.

While the method of electric induction heating is new, it depends on a basic law of physics. If an electric current is passed through a coiled wire, it forms a magnetic field, and if a steel ingot or any other conductor is placed in this field, an electric current is also induced within the ingot. Resistance to this current heats the ingot—up to

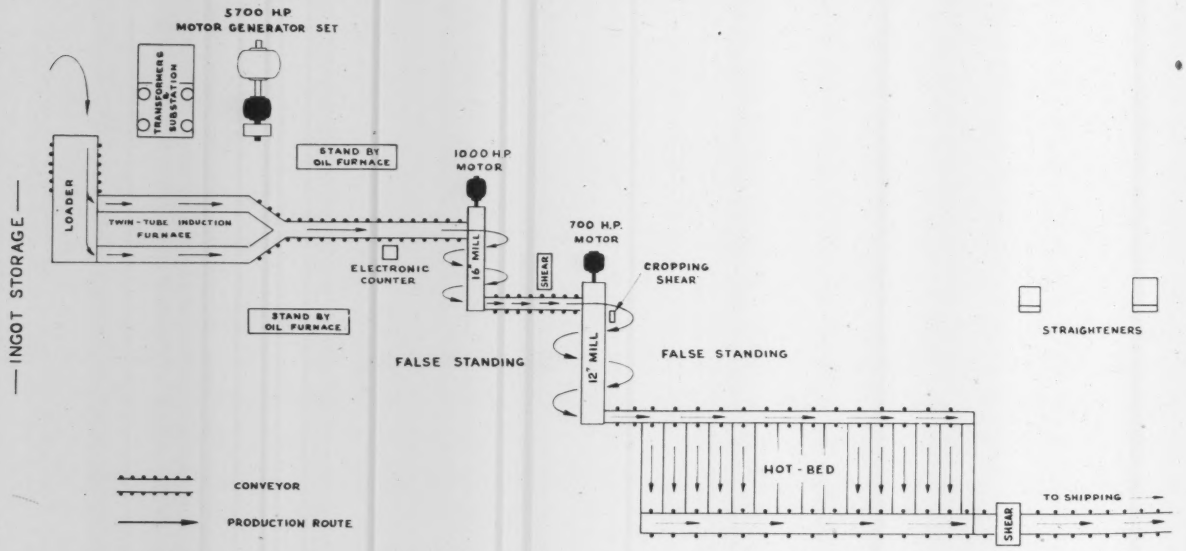


Fig. 9 Diagram of production flow of electric induction-heated steel ingots at Vancouver Rollings Mills Ltd., Vancouver

Fig. 11 Red-hot ingot spews out of 16-in. mill at Vancouver Rolling Mills after reaching temperature of approximately 2300 F in world's largest electric induction-heating unit. The mill is powered by a 1000-hp motor.

almost 2300 F. Control of the amount of current used determines ingot temperature.

The induction-heating unit comprises a series of large copper coils set in refractory blocks placed end to end to form a tunnel. Ingots are fed in at one end of the tunnel, pushed slowly through, and emerge at the other end almost white-hot, ready for rolling into finished steel bars.

The heat produced is so intense that if the ingots were left in the furnace for even half a minute too long, they would melt. The whole operation is one of split-second timing. Unless the gigantic magnetic forces employed are delicately balanced and harnessed, red-hot ingots weighing up to 800 lb could fire out of the tubes onto the rolling mill floor like torpedoes.

The 60,000-volt power supplied by a substation is converted by a bank of three 3000-kva transformers and one 4000-kva transformer to 500 volts, before being conducted to the coils by almost 700 miles of heavy copper wire.

The tunnel is divided into two portions. The first, the low-temperature half, uses low-frequency 60-cycle ac. In the second half, where maximum heat is obtained, a frequency of 600 cycles is required. This 600-cycle power is supplied by a 5700-hp motor-generator.

The heart of the furnace operation is the control pulpit. This is a square aluminum cabin placed directly over the tunnels, where one man supervises the controls. These control instruments inform the operator instantaneously of the exact conditions of power consumption, heat, feed rate, and all other factors in every part of the installation. He can tell, at a glance, for instance, if the coolant water in the copper coils is becoming too hot or electrically conductive.

Controlling the flow of steel through the heating tunnels at a speed of about one ingot every 20 sec, the operator must watch this flow to the rate of production of the rolling mill, so that ingots are at just the right temperature for rolling when they run down the conveyer.

When the red-hot ingot emerges from the tunnel onto an automatic conveyer, it is fed into the first set of rolls, which is a 16-in. breakdown mill. The fiery ingots, which are about $4\frac{1}{2}$ ft long and 5 in. in diam, get progressively longer and thinner as men pass them in and out of a series of rolls. In a matter of three or four minutes they have obtained a length of about 200 ft and can be reduced to as little as $\frac{1}{8}$ in. in diam. When they emerge from the last rolls en route to the "hot bed" for cooling, they travel up to 1000 fpm. Their journey is largely controlled by automatic and semiautomatic equipment.

The bars are allowed to cool on a latticework of steel called a hot bed. After cooling, the bars are cut into appropriate lengths, straightened, and tied into 5-ton bundles, secured with steel bands for safe shipment.

Isoscope

An inspection tool that uses radioactive Cobalt 60 and is capable of radiographing—or "seeing through"—thickness of steel up to 7 in., has been developed by The Babcock & Wilcox Company at Barberton, Ohio. Called the "Isoscope," the tool has been under study

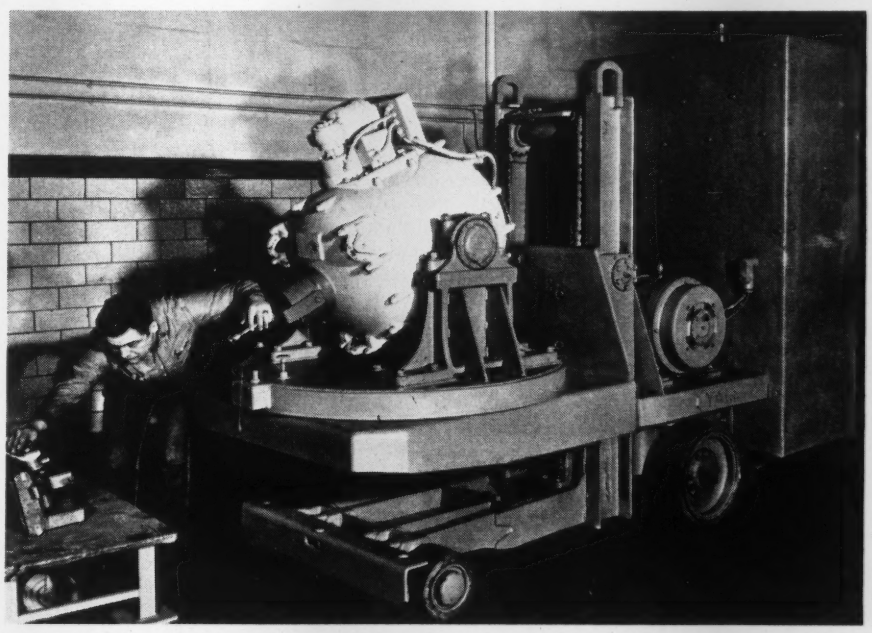


Fig. 12 The Isoscope which makes use of radioactive Cobalt 60 and is capable of radiographing thickness of steel up to 7 in. is being "aimed" at a test specimen. The new inspection tool, under development at The Babcock & Wilcox Company's Barberton, Ohio, works for the past three years, requires only one third the exposure time of a million-volt x-ray unit.

and development by B&W for the past three years. It requires only one third the exposure time of a million-volt x-ray unit and is said to pave the way for wider use of atomic energy in this industrial application.

The largest allocation of radioactive Cobalt 60 ever authorized to industry for radiographic work was assigned to B&W for the Isoscope at Oak Ridge National Laboratory on Oct. 11, 1954. The material was loaded into a special dual-purpose spherical lead container designed and built by B&W's Barberton, Ohio, works to handle the radioactive material during shipment. The container is converted into a part of the radiographic machine upon arrival at its destination.

The lead sphere of the Isoscope is encased in a steel jacket having a cylindrical rotor section built into it. By revolving the rotor 180 deg the radioactive source can be brought from the "safe" position to a point in line with the coned opening in the steel jacket allowing a beam of radiation to escape. This, in effect, results in a unit which can be turned "on" and "off."

The total charge placed in this unit was 1008 curies of Cobalt 60. The charge is comprised of small disks stacked one on top of the other like coins in a coin changer. The radiation is taken from the top of this stack so that the focal spot size compares favorably with existing high-voltage x-ray equipment.

The balance of the Isoscope consists of a modified electric platform lift truck having a "lead cab" built on back and a "turntable" mounted on the front platform. Trunnions on the turntable receive the lead ball containing the radioactive material. Cover plates mounted on top and bottom of the lead balls carry the cylindrical rotating mechanism. This assembled unit can be raised or lowered through 8 ft, rotated vertically through 210 deg and horizontally through 360 deg.

The lead cab provides protection for the operator and contains controls for the operation of the machine. The controls consist of a timer, an on-off button and a green, amber, and red-light system which informs the operator of the position of his source at all times.

A few of the outstanding advantages of this unit over high-voltage x-ray equipment, according to the announcement, are as follows: (1) Lower initial cost; (2) less amount of shielding necessary for secondary radiation; (3) greater mobility; (4) the maintenance and operating costs are a known factor and can be predetermined. This predetermination cannot be accurately made for the one and two-million-volt radiographic equipment; (5) a mechanical breakdown would not stop the examination being made since the Isoscope may be operated manually and the examination completed before mechanical repair is attempted; (6) the simplicity of controls eliminates the need of a highly trained technician for its operation.

Smog-Muffler Tests

THREE months of rigorous road testing of the Houdry catalytic converter have convinced scientists of the Air Pollution Foundation of Los Angeles, Calif., that the auto muffler is not yet ready to be recommended as a potential smog eliminator for public adoption. (See MECHANICAL ENGINEERING, May, 1955, page 431.)

In announcing the completion of exhaustive tests of the device on the proving grounds of Southwest Research Institute at San Antonio, Texas, the Foundation reported that the converter proved capable of removing more than 80 per cent of an auto's hydrocarbon emissions when first attached, but that it appears to wear out too soon to warrant Foundation endorsement.

The tests were originally scheduled for 20,000 miles but were concluded at the end of 10,000 miles.

Four Houdry mufflers were installed on cars of different makes using leaded gasoline. The devices showed a high efficiency at the start of the runs, but the efficiency tended to decrease in varying degrees after 2000 miles.

The Foundation attributed the decrease in efficiency to mechanical-design problems and loss of activity of the catalyst. Because some design changes were found necessary, no attempt was made to rejuvenate the catalyst after its activity declined.

The devices have been shipped to the plant of the inventor, Eugene J. Houdry, president of Oxy-Catalyst, Inc., at Wayne, Pa., where they will be checked and restudied by engineers.

Purpose of the tests was to determine whether the Houdry muffler would eliminate a major percentage of hydrocarbon emissions for a reasonable period of time without repairs or replacement, and whether the device could be recommended by the Foundation for widespread installation in the Los Angeles area.

Once-Through Boiler

ACCORDING to a recent announcement, the Dayton Power & Light Company, Dayton, Ohio, has placed a contract with Combustion Engineering, Inc., New York, N. Y., for a C-E Sulzer Monotube Steam Generator.

Although this is the second C-E Sulzer unit to be ordered in this country, it will be the first of the "once-through" type to operate at a steam pressure in the "subcritical" range and will be larger than any such unit elsewhere.

The previous unit, ordered last year by Philadelphia Electric Company, is designed for the supercritical pressure of 6000 psig—the highest steam pressure adopted to date anywhere in the world. The steam temperature for this unit, 1200 F, also establishes a new world record. Only one other supercritical pressure boiler has thus far been ordered in America, and there are none installed abroad.

Although the Dayton installation will be the first once-through boiler in this country for conventional pressure, there are a large number of such installations in Europe where metal shortages and other factors have favored the use of drumless-type boilers.

While this type of boiler is the only type suitable for supercritical pressures, in the conventional range it must compete with American designs which have established outstanding records of economic performance and reliability. Notable among these is the C-E Controlled Circulation Boiler, a design especially suited to the higher range of subcritical pressures (2200 to 2700 psig) now indicated as the pressure range most likely to be adopted for the large utility installations that will be ordered in the next few years. Both the controlled circulation and once-through designs have special features, the evaluation of which with respect to load, operating, and other conditions of particular plants, will simplify the problem of selection.

The Dayton unit is to be installed at the Company's Frank M. Tait Station in Dayton where it will serve a 125,000-kw turbine-generator. It will supply steam at a pressure of 1800 psig, with a primary steam temperature of 1000 F and a reheat temperature of 1000 F.

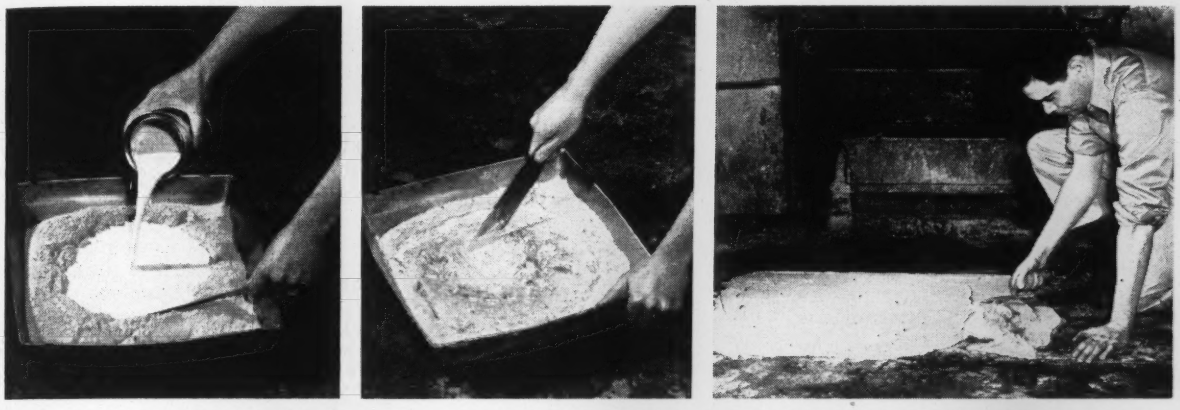


Fig. 13 Liquid rubber (*left photo*) is added to a cement base on the job to make a batch of Laticrete, a rubber-cement blend developed by the Naugatuck Chemical Division, United States Rubber Company. The new rubber-based cement has a flexibility that allows it to give instead of crack under heavy loads. It is also waterproof, resistant to mild acids and alkalies, and has a nonskid quality. It is designed for use as a top surfacing material to repair damaged concrete floors or to repair cracks. Laticrete can be mixed with standard mortar equipment (*center photo*). Small batches, such as this, or large amounts can be made in the same way that concrete is handled. It is also applied in the same manner, and can even be buffed to get a smooth finish. A concrete floor (*right photo*) that has been attacked with acid is repaired with Laticrete.

Concrete-Type Flooring

A NEW concrete-type industrial flooring and construction material that "gives" without cracking under heavy loads, dampens shock and noise, resists alkalies and mild acids, is waterproof, and has a nonslip quality, has been developed by Naugatuck Chemical Division, United States Rubber Company.

The material is a combination of liquid rubber and a special cement powder and is called Laticrete. The rubber content makes it so flexible when hard that a long thin slab can be bent into a circle by hand. The rubber also gives the cured mix "bounce" and a tight bond that makes it resist breakdown under heavy use. Test patches in factories show virtually no wear after two years of high-volume traffic.

The concrete-rubber mix is a surface coating and can be used for repair work or in new installations. It has good adhesion to concrete, metal, and even glass. A $^1/_4$-in. layer, the suggested thickness, will support heavy loads such as fork-lift trucks when put down over a hard base.

Laticrete comes in two parts—the powder and a liquid rubber—and is prepared like regular concrete. Standard masonry equipment is used both to mix and apply it. One of the few requirements in using it is that it must be applied to a clean surface. Dust, oil, and other foreign matter prevent a bond to the base material. Any acid on the surface to be coated must be neutralized before putting down the surfacing material. Otherwise, it is handled like concrete or mortar and can be troweled or buffed to give a smooth surface.

In development for the past six years, the material is now being evaluated by approximately 60 companies. Laticrete was pioneered by the rubber company's Canadian subsidiary, Dominion Rubber Company, Ltd., and a number of test installations have been made in Canada. Represented in the test group are chemical, footwear, textile, sugar, drug, dairy, paper, automotive, electrical, shipbuilding, and rubber companies.

The test applications include repairing worn concrete floors, installing new floor toppings, cushioning pads for heavy machinery, protecting floors and equipment subject to chemical attack, putting nonskid surfaces on ramps used by fork-lift trucks, waterproofing the interiors of storage tanks, patching damaged concrete walls, putting a noise-deadening layer on hard-surfaced floors, eliminating dusting conditions on floors in food and drug plants and also in hospitals.

These tests have shown the material hardens in a few hours and is ready for use after two or three days of curing. This delayed-cure effect turned up in a test installation on a damaged concrete area over which tractors operated. A day after the installation a tractor driven across the test strip left an indentation. But a few days later tractors could be driven over without leaving marks, and the topping deadened the noise of the metal treads and also prevented further breakdown of the floor.

Other laboratory and factory tests show the rubber-based flooring has roughly the bounce of a hardwood floor and is about two thirds as hard as concrete. From a strength standpoint, it will take compressive loads of 2500 psi. Its adhesion to concrete is 300 psi, and it also has good adhesion to clean surfaces of steel, aluminum, brick, tile, and glass. Adhesion to glass is 100 psi. It also resists cracking over a wide temperature range.

The light-gray mix can be pigmented in a wide range of colors. Its cost is above concrete, but below acidproof brick or tile. Both the liquid rubber and special cement powder are being supplied by Naugatuck Chemical.

180,000-Kw Nuclear-Power Plant

DESIGN of a new atomic-power reactor, described as a "major advance toward the economic generation of electricity from atomic energy" has been announced by Francis K. McCune, Mem. ASME, General Electric Company, vice-president and general manager of the company's Atomic Products Division.

Mr. McCune said that one of these new dual-cycle boiling reactors will power the proposed full-scale nuclear-electric generating station that G-E will construct, subject to AEC approval of the project, for the Commonwealth Edison Company near Chicago, Ill.

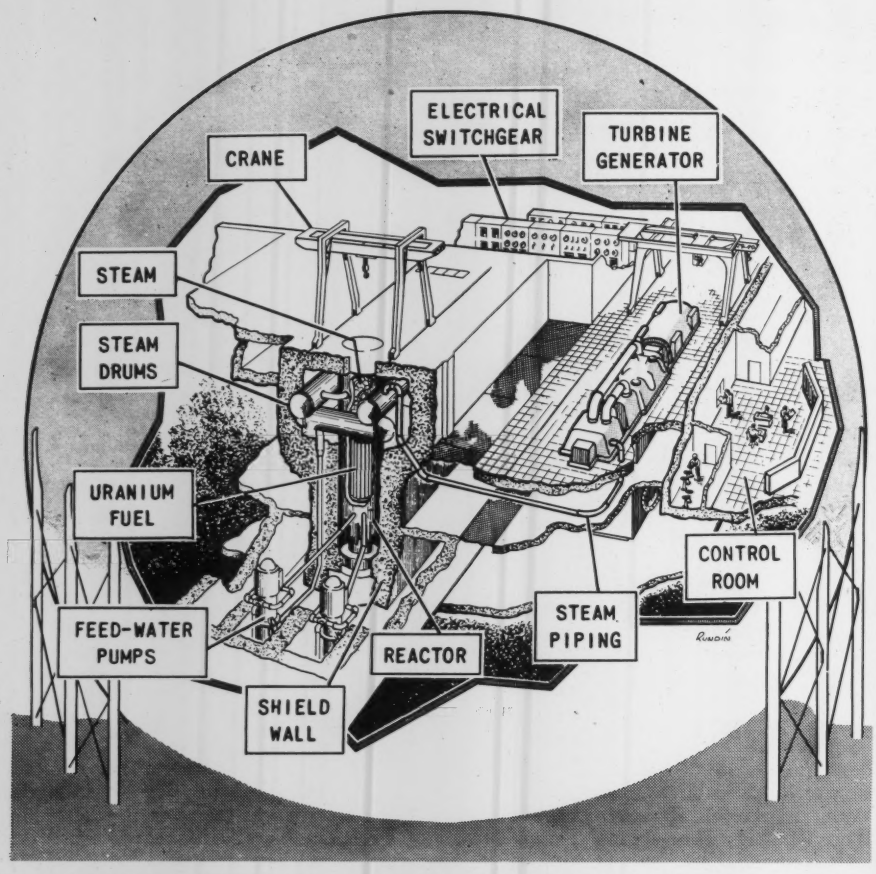


Fig. 14 Artist's drawing shows a cutaway view of the 180,000-kw boiling-water reactor nuclear-power plant proposed for the Chicago area. The reactor, turbine-generator, and related equipment will be enclosed in a steel sphere about 200 ft in diam. Fissioning uranium produces heat which causes the water in the reactor to boil and form steam. The steam flows through pipes to the turbine. As in a conventional power plant, the steam then drives the turbine spindle which spins the generator to make electricity. This type of reactor was developed at Argonne National Laboratory.

Plans for the plant set the generatingc apacity at 180-000 kw, the largest all-nuclear station yet scheduled. The plant will be located on a 750-acre site near the confluence of the Kankakee and Des Plaines rivers in Grundy County, Ill., and will be owned and operated by the Commonwealth Edison Company.

Mr. McCune said the new G-E power-reactor design will be able to produce several times as much power in a given size as its predecessor, the direct boiling reactor. The dual-cycle boiling reactor is a type expected to achieve competitive generating costs with ordinary steam-power plants in succeeding models.

The G-E reactor was described by Mr. McCune as capable of being used without heat exchangers by generating steam directly inside the reactor core, thus eliminating the need for high operating pressures and temperatures used in liquid water-cooled power reactors.

The proposed Illinois station will be sponsored by the Nuclear Power Group, Inc., and will be financed completely with private funds. Sponsoring companies are: American Gas and Electric Service Corporation, Bechtel Corporation, Commonwealth Edison Company, Pacific Gas and Electric Company, Union Electric Company, of Missouri, Central Illinois Light Company, Illinois Power Company.

In describing improvements made by G-E engineers in their dual-cycle design, over the more conventional boiling reactor, Mr. McCune said:

"Much of the simplicity and thermal efficiency of the boiling reactors has been retained, while the power for a given size has been boosted materially."

He said that the original concept of the direct boiling reactor, pioneered at the Atomic Energy Commission's Argonne National Laboratory by Dr. W. H. Zinn and associates, was adapted by General Electric for use in a large power station. In doing so, G-E engineers found ways to multiply the output of such reactors, permitting their application to large power plants on a commercial scale.

He explained that the inherent safety of the direct boiling reactor had been retained in the G-E dual-cycle design and, at the same time, stability with relation to load had been vastly improved.

When increased load demands are made on the direct boiling reactor, output tends to be reduced "just when power is needed most," the G-E official said.

G-E engineers introduced a "flash-tank" system into the new reactor which controls steam formation by feeding cooler water into the entrance of the reactor as load demands increase. This maintains the delicate balance of the chain reaction in such a way that the reactor automatically delivers more power to supply the load increase.

The dual-cycle reactor, in effect, Mr. McCune said, accommodates itself to the demands of the power system without requiring changes in reactor controls. Steam is provided to the turbine at two pressures. He gave, as an example, 600 psi from the reactor vessel for the first turbine stages and 350 lb from the flash tanks for immediate stages.

In contrast, he said, nonboiling reactors cooled by high-temperature, high-pressure water would have to operate under a pressure of around 2000 lb in order to generate steam at 500 lb for the turbine.

The dual-cycle reactor also has the following advantages: (1) Primary loop pressure essentially the same as turbine pressure; (2) good thermal efficiency for a given reactor temperature; (3) exceptionally high degree of

inherent safety due to boiling in the reactor; (4) flexibility of operation to meet power-demand changes without delay; and (5) self-stabilizing power level to match load variations.

Low-Cost Nuclear-Power Plant

An advanced type of nuclear-power plant that can be designed and built by 1960–1961, at a cost that will be competitive with some present-day power-station costs, was announced recently by Foster Wheeler Corporation, Wilkes Barre, Pa.

The plant being offered by Foster Wheeler to the utility industry will utilize the aqueous homogeneous-power-breeder system, which the Atomic Energy Commission, in a report to Congress, had rated as a "long-term" possibility. Such a plant, with an electrical capability of 100,000 kw, can be built now at an estimated cost to the owner of $21,000,000—within the price range of a conventional power station, it was said.

With this type of plant, the announcement said, electric production costs will depend, as usual, upon factors such as system load characteristics, plant location, and method of financing. However, electric costs could be as low as six to nine mills per kwhr. (Based on published AEC estimates, seven-mill electricity would be competitive with 16 per cent of the present market.)

Design work for the aqueous homogeneous-power breeder is based on successful operating experience of the AEC at Oak Ridge with a homogeneous-reactor experiment.

The aqueous homogeneous-power-breeder system essentially utilizes a spherical core containing a solution of uranyl sulphate in heavy water in which the fission of uranium 235 generates the heat required. The fuel solution is pumped through the core to four steam-generator heat exchangers in which saturated steam at 600 psi is produced by the heat the fuel solution gives up. The dimensions of the core vessel are such that the fuel solution becomes critical as it circulates through the vessel.

In order that the equipment be practical and of manageable size, four heat exchangers are used; this also permits any one of the heat exchangers to be isolated for servicing when necessary.

Four canned rotor pumps are used to circulate the fuel through the core and through the heat exchangers. The core is connected to a system of noncritical dump and storage tanks. The solution may be drained out of the reactor system into these tanks when desired for shutdown and maintenance. This dumping arrangement is controlled by a hydraulic pressure-balanced system to eliminate large valves. A separate vessel connected into the highest point in the system serves as a pressurizer and surge tank. The desired operating pressure is maintained by electric heaters in the pressurizer.

Breeding is accomplished in a blanket containing a fertile material in a spherical vessel surrounding the core vessel. The fertile material will be thorium 232, which is converted to uranium 233 in the breeder blanket. The uranium 233 is used to refuel the reactor. The thorium in the breeder blanket, in heavy water, is pumped through the blanket vessel. Approximately 17 per cent of the total reactor heat output is generated in the blanket. Two heat exchangers are used to extract the heat from the blanket material and to generate additional steam at 600 psi. Two canned rotor pumps circulate this material through the blanket and through the heat exchangers. The blanket circuit is connected to a dump tank similar to that used for the core. The pressurizer in the core circuit is also connected to the blanket circuit to maintain essentially equal pressures in both circuits.

A reprocessing system for the core material is included to remove the majority of the gaseous and insoluble fission-product poisons as they are being formed in the process.

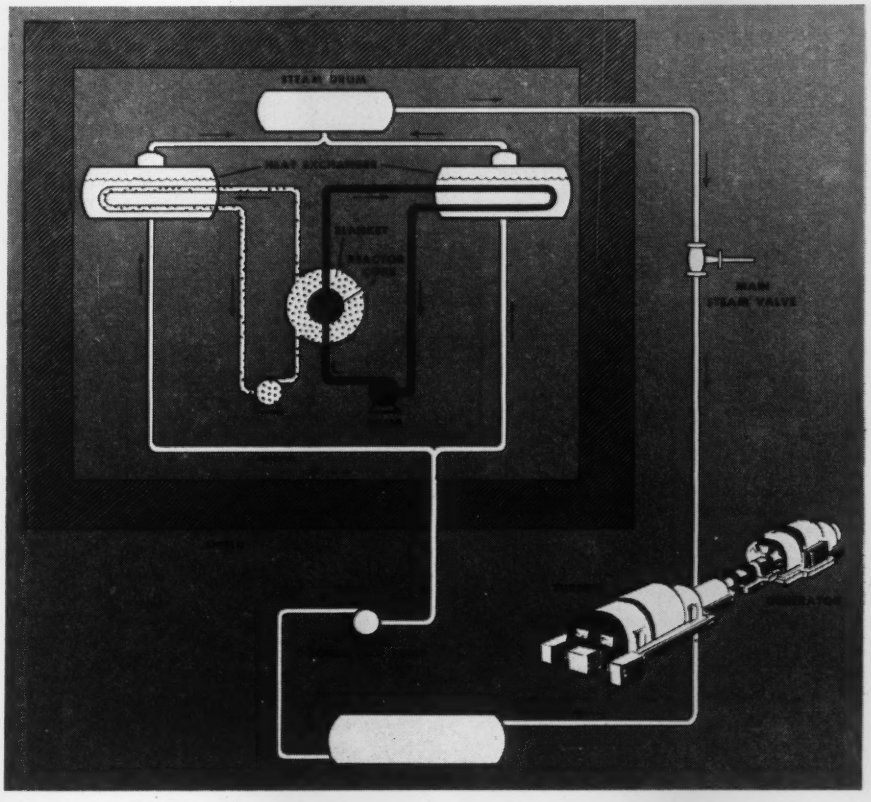
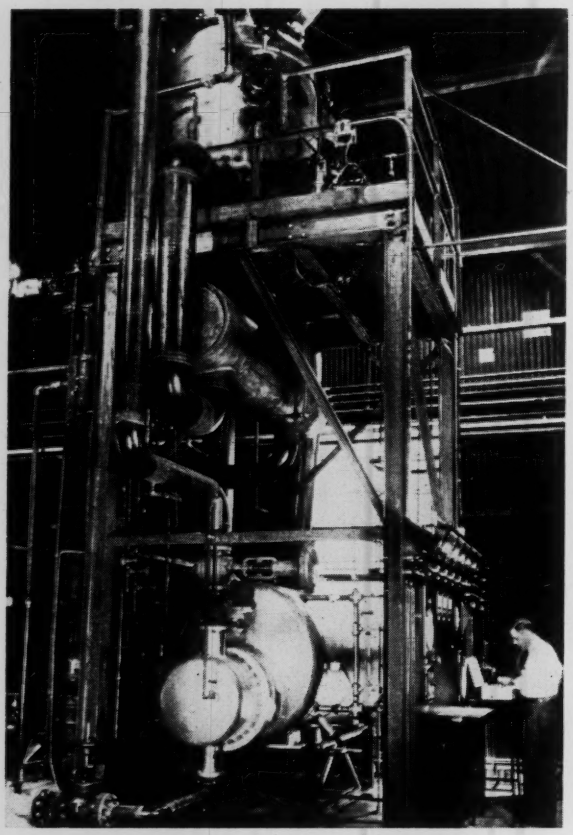


Fig. 15 Sketch of Foster Wheeler aqueous homogeneous-power-breeder system. This type of power plant with an electrical capability of 100,000 kw can be designed and built by 1960–1961 at a cost competitive with some present-day power-station costs, the company said.

Atomic Energy. This atomic-energy test area at the Babcock & Wilcox Research Center, Alliance, Ohio, is where various tests are in progress for the development of components for atomic-energy applications. Both high-pressure water-cooled reactor systems and liquid-metal-cooled reactor systems are being investigated here. Carbon steel and other economically available materials of construction are currently being investigated for possible use in commercial power-reactor plants. Other projects include: Proof tests for proposed heat exchangers, pressure-vessel stress studies, closure tests, material tests, and thermal-shock tests.

B&W RESEARCH CENTER

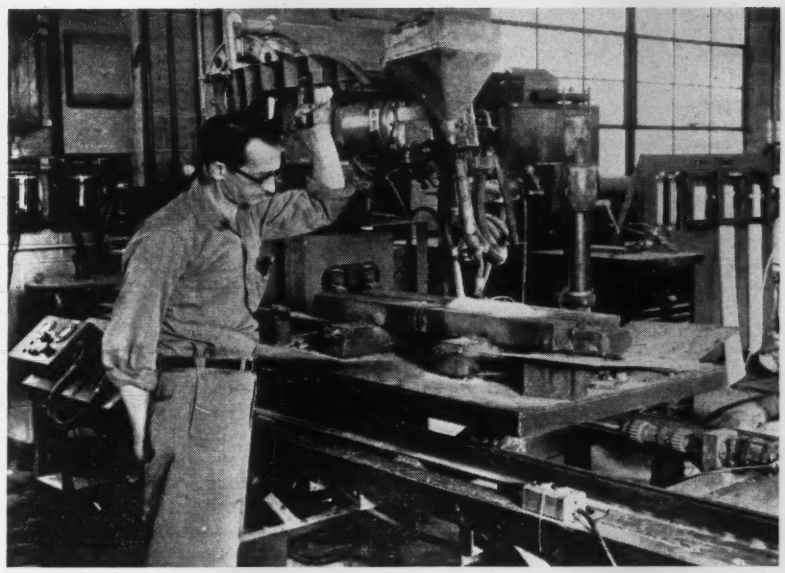
...Covers Diversified Fields

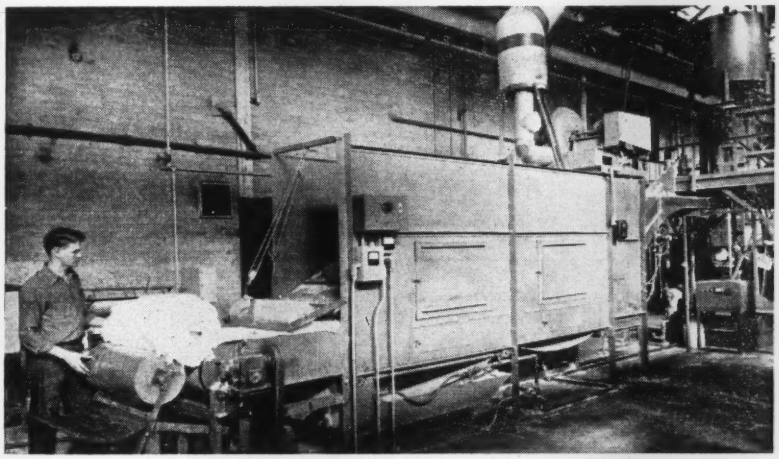


Engineering Physics. With this steam-water separating test equipment the Fluid Flow and Heat Transfer Group is developing devices for separating steam and water, and for removing boiler-water solids, such as silica, from steam. It is also studying flow distributions and pressure-drop calibration of steam equipment. The Electronics Section designs and constructs many special instruments and controls for use in B&W's Research Center. The Stress Analysis and Design Group, among other jobs, measures stresses in pressure vessels and is conducting tests for stress rupture, creep, fatigue resistance, and resistance to stress corrosion.

Creep Laboratory. The Creep and Stress Rupture Laboratory at the B&W Research Center comprises 136 stations where tests are conducted to investigate the long-time behavior of alloys under conditions of stress and high temperature. This is believed to be the largest laboratory of its kind in the country. Work is being conducted here in testing new metal alloys for use in tubes for superheaters and ultimately developing tubes for use at higher temperatures and pressures than are possible today. New alloys tested here have been accepted for critical work by the U. S. Air Force and have helped to push temperatures and pressures in boilers ever higher.

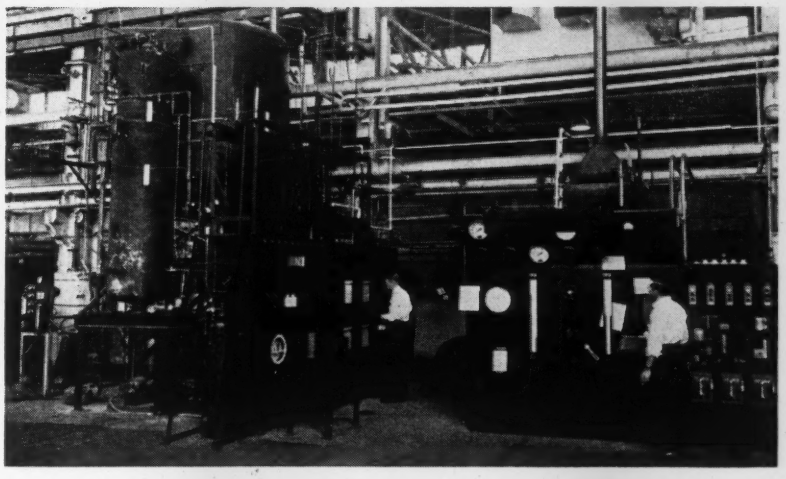
Welding. This new automatic submerged-arc welding process which will deposit metal up to five times as fast as comparable welding methods and at half the power cost, is in final stages of development at the Center. In addition, emphasis recently has been placed on the welding of titanium, tungsten, and zirconium, a technique essential to the fast-growing atomic-energy industry; on the welding of dissimilar metals; and on perfecting of the new high-speed process. New welding metals for use in the atomic field are also being investigated, and the design of welding equipment is constantly undergoing improvement.





Kaowool Insulating Refractory. Pilot plant for the production of B&W Kaowool insulation refractory blankets at the Research Center is shown here. Design of the pilot plant resulted from a new method of manufacturing Kaowool recently developed at the Center. Currently, Kaowool is being used as an insulating blanket in the afterburners and tail pipes of jet engines, where it successfully withstands temperatures up to 2000 F, indefinitely. The material is also being tried out as insulation in trucks and cars, filling for life preservers, reinforcement for plastics, and as a resilient packing for kilns, hot-air ducting, and annealing ovens.

Steam-Generation Research Station. Data on the behavior of steam at pressures up to 5000 psi are being gathered in this above-critical test unit, which comprises a single-tube steam generator with separately fired superheater. It is fully equipped with controls and has apparatus for sampling and analysis of feedwater. In this unit, pressure drop, heat-transfer, and feedwater characteristics are being studied. Below-critical steam studies are being carried on in a special closed-loop pilot unit. Experiments are being conducted that are expected to lead to the optimum arrangement of tubes in a boiler.



European Survey

Engineering Progress in the British Isles and Western Europe

J. Foster Petree,[1] Mem. ASME, *European Correspondent*

Power From the Wind

For several years experiments have been going on in the British Isles, sponsored by the British Electricity Authority in England and the North of Scotland Hydro-Electric Board in the area of Scotland that they cover, to investigate the possibilities of using wind power for the generation of electricity on a useful scale. The inquiry was directed particularly to the circumstances in the more remote and exposed parts of the country, where windless days are the exception and where distribution costs of a supply from thermal or hydroelectric stations to a sparse and widely scattered population would be high in relation to any likely demand. The authorities concerned have not attempted anything comparable in size with the short-lived Grandpa's Knob plant in Vermont, which drove a 1250-kw generator; but the 100-kw installation that has been undergoing tests recently at St. Albans, about 20 miles to the northwest of London, can certainly compare in technical interest with any system yet tried.

The plant works on what is known as the depression principle; that is, the function of the windmill is not to drive any mechanism by direct gearing but to create a partial vacuum within the tubular tower, so that air is drawn into the turbine situated in the base of the tower, thus driving an alternator. The method of producing the partial vacuum (the invention of a French engineer named Andreau, who died before he could complete more than preliminary experiments with it) is simple, but highly effective. The blades of the windmill, of which there are two in this instance, are hollow and have orifices at their tips through which the air contained in them is expelled by centrifugal force as the blades rotate, thus reducing the pressure in the head or hub, which is in direct communication with the interior of the tower. The arrangement has the great advantage, from the standpoints of structural design and ease of maintenance, that the turbine and alternator are in the base of the tower on a rigid foundation and the further advantage, on the mechanical side, that there is no need for any clutch or speed-compensating device between the windmill and the turbine, the effective connection between them being solely the column of air within the tower.

The tower is 9 ft in diam at its base and stands on a foundation of reinforced concrete. It is further secured by 12 radiating guy wires attached to anchors set on a pitch circle 96 ft in diam. The height to the horizontal axis of the revolving head is 100 ft and the over-all diam of the path swept by the blade tips is 80 ft. Above the brackets to which the guys are attached the diameter of the tower is 3 ft 6 in. The total weight of the tower and mill is 60 tons and the blades weigh 1600 lb each. They are held at their roots by coned bearings which allow them to take up positions of equilibrium under the combined effects of centrifugal force and the pressure of the wind, and normally, when running, they lean away from the tower at an angle of about 5 deg. The maximum range of this movement is between 8 deg forward (that is, toward the tower) and 18 deg backward. The cone on the hub points downwind when running. Hydraulic shock absorbers, with variable rates of damping, cushion the movement of the blades, and a wind-direction indicator controls the orientation of the head.

The windmill is designed to rotate at 100 rpm with a wind speed of 30 mph, and at this speed 58,500 cfm of air are drawn through the turbine. At lower wind speeds

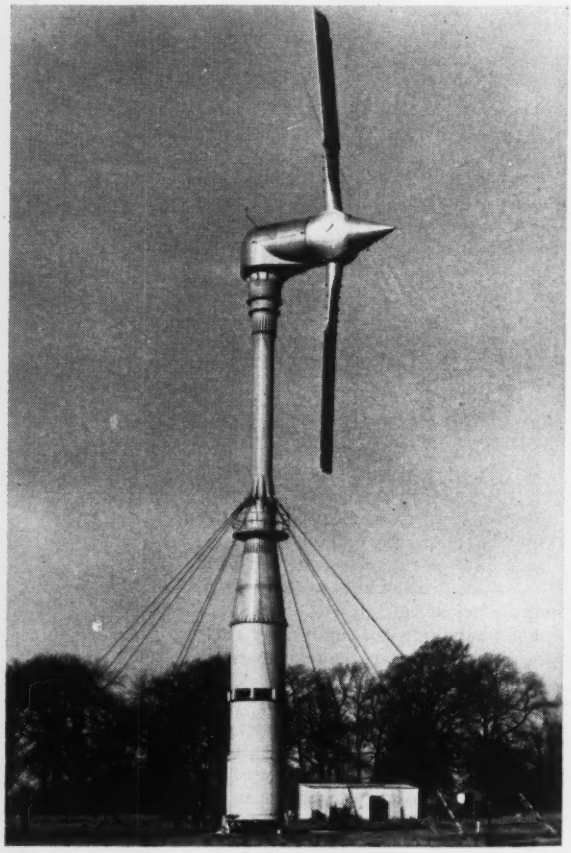


Fig. 1 100-Kw depression-type windmill generator

[1] Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

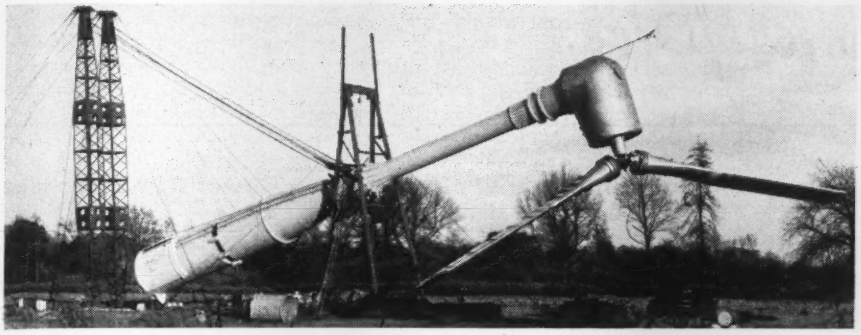


Fig. 2 Erecting 100-kw windmill generator. Total weight of tower and mill is 60 tons and the blades weigh 1600 lb each.

the blades are held at a constant pitch, but at higher speeds the pitch is varied automatically to maintain a constant 100 rpm, so that the air intake also remains constant. At speeds above 65 mph the blades are completely feathered and rotation ceases. The head rotates in the horizontal plane about a vertical shaft or spindle at the top of the tower and contains, in addition to a lubrication pump, the hydraulically controlled motors which change the pitch of the blades. They are capable of changing the pitch by 20 deg in one second and are oil-actuated. A governor, driven from the main shaft, controls the valves which admit the oil to the motors. There is also an overspeed emergency control which energizes electrically operated valves which admit high-pressure oil to the motors from a reservoir maintained at 350 psi, feathering the blades almost instantaneously if the mill is struck by a violent gust.

The turbine is situated in the upper part of the 9-ft-diam portion of the tower, above the belt of air-inlet ports, at a height of about 20 ft from the ground. It is of the axial-flow single-stage type and has a rotor 48 in. in diam. There are 47 blades on the rotor and 50 in the stator, and the air is injected at an angle of 28 deg. The rotor is designed to run at 1000 rpm and the turbine has an estimated efficiency of 85 per cent. Mounted below the turbine and coupled to it by a freewheel mechanism is the 100-kw synchronous alternator, which delivers three-phase current at 415 volts. The exciter is carried on the shaft. The controls are assembled in the lowest part of the tower, beneath the alternator, and are designed for completely automatic operation. When running up to speed, the alternator acts as an induction motor, taking current from the public supply through an 11,000/415 volt 200-kva transformer, and until it reaches a speed of 1000 rpm it rotates independently of the turbine. When that speed is reached the freewheel mechanism locks the turbine to the alternator shaft and the synchronous motor then functions as an alternator. At wind speeds below 30 mph, when, as stated, the blades are held at constant pitch, the turbine speed is maintained at 1000 rpm by the alternator, but the output falls.

The main contractors were Enfield Cables, Limited. Subcontractors included De Havilland Propellers, Limited; Redheugh Iron and Steel Company (1936), Limited; and the English Electric Company, Limited.

Deep-Hole Boring Machine

THE Swiss Industries Fair, which has long been one of the most important European exhibitions of machine tools on a purely national basis, opened at Basel, Switzerland, on April 16, for 11 days. Naturally, many of the exhibits in the machinery section were associated with the great national industry of watch and clockmaking, but there were also a variety of machines of more general engineering application.

One of these was a two-spindle machine for drilling deep holes in rifle barrels, arbors, etc., shown by the Schweizerische Industrie-Gesellschaft, of Neuhausen am Rheinfall.

This machine will drill holes from 5 mm to 16 mm in diam to depths up to 800 mm (2 ft $7\frac{1}{2}$ in). Carbide tools are used, and the rigid construction of the bed and the liberal provision of steady bearings and drill bushings permit speeds up to 6000 rpm to be maintained.

The drilling of rifle barrels made of steels with tensile strengths from 90 to 130 kg per sq mm (in round figures, 57 to 82 tons per sq in.) has been successfully accomplished with feeds of 120 to 150 mm (5 to 6 in.) per min; but the full range is more extensive, the feed (which is hydraulically actuated) being steplessly variable between 10 and 250 mm ($\frac{1}{2}$ in. to 10 in.) per min.

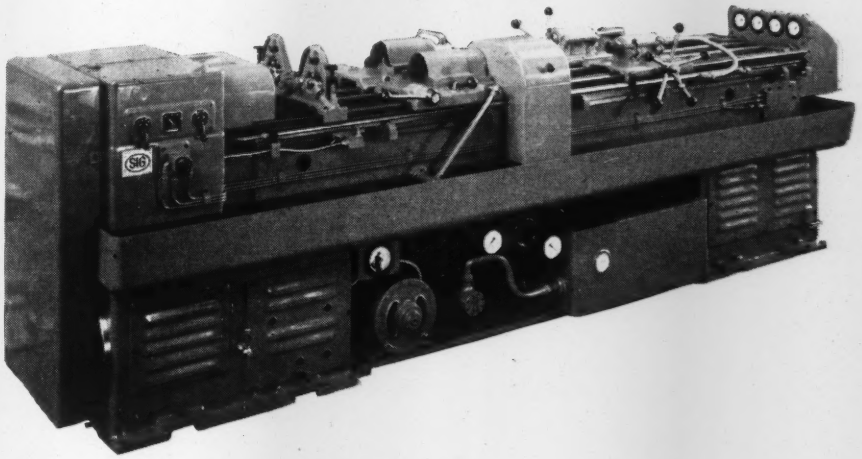
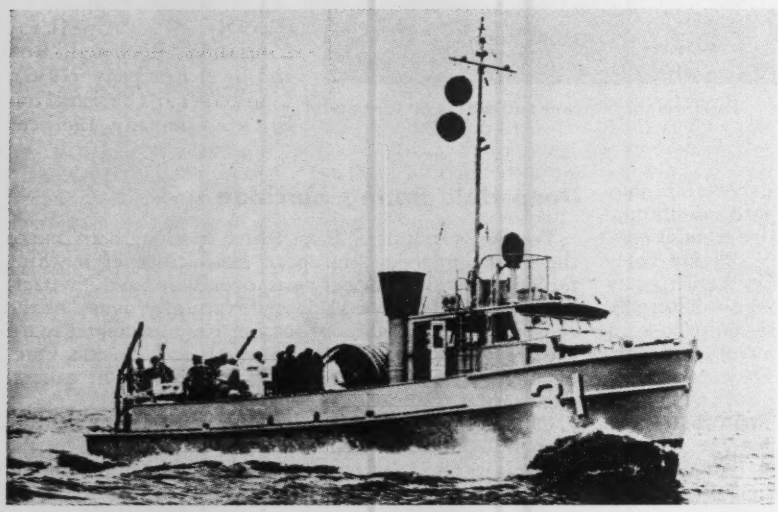


Fig. 3 Two-spindle machine for drilling deep holes in rifle barrels, arbors, and the like

ASME Technical Digest

Substance in Brief of Papers Presented at ASME Meetings



Boeing model 502-6 gas-turbine engines are being used to power the minesweeping generator gear of this MSB-5 Class Minesweeper

Gas Turbine Power

Evaluation of a Naval Gas-Turbine Engine, by J. A. Culver, Department of the Navy, Washington, D. C., and A. L. Wood, Boeing Airplane Company, Seattle, Wash. 1955 ASME Spring Meeting paper No. 55—S-44 (multilithographed; available to Feb. 3, 1956).

THIS paper gives an evaluation of the first production marine gas-turbine engines used by the U. S. Navy.

In November, 1952, the first of the MSB-5 Class Minesweepers was completed and turned over to the Operating Forces of the Navy. Included in the machinery arrangement were two minesweep generators, each being driven by two Boeing 502–6 gas-turbine engines through a combining reduction gear. As of Jan. 1, 1955, there are 44 MSB's in service with a total of 176 Boeing engines installed. Two hundred and thirty engineers are included in the program. The paper presents factual operation and maintenance data accumulated on Boeing gas-turbine engines installed in Navy Minesweeping Boats from the period of initial boat qualification tests up to January, 1955. This data contains all known mechanical interruptions of the gas-turbine engines during this period.

The Development of a 500-Hp Multipurpose Gas-Turbine Engine, by P. G. Carlson, Mem. ASME, and I. N. Swatman, Solar Aircraft Company, San Diego, Calif. 1955 ASME Spring Meeting paper No. 55—S-36 (multilithographed; available to Feb. 3, 1956).

THE initial Jupiter Series gas-turbine engine was delivered to the U. S. Navy in 1950. This prototype gas-turbine engine, designated the Solar Model T-400J, was applied as a prime mover in a shipboard emergency generator set. The generator set was installed in the USS *Timmerman* in January, 1951, becoming the first gas-turbine engine ever installed in a U. S. Navy ship.

While the emergency generator set incorporating the T-400J engine had a reasonable record for availability during its shipboard use, the job of keeping the set suitable for emergency operation required considerable effort. It became apparent that an extensive development program, aimed at improving the durability and performance of the engine, would be necessary if the engines were to be used in applications where extended operating periods are involved and a long overhaul life required.

Accordingly, a new program was undertaken under Bureau of Ship's sponsorship, having the following objectives: Redesign of engine components found to be troublesome in the T-400J engine; increase the power output and thermal efficiency over those of the prototype unit; and conduct a development program involving extended engine running time to prove the reliability of the modified engine.

The desirability of a multipurpose gas-turbine engine became evident, and it was decided that the design modifications should provide for making either a single-shaft or two-shaft engine from substantially the same components. The single-shaft engine was designated the Solar Jupiter T-520J, and the two-shaft version as the T-522J.

This paper describes the development of these later models of the Jupiter series gas-turbine engines.

Sulphur Dew-Point Corrosion in Exhaust Gases, by R. L. Coit, Assoc. Mem. ASME, Westinghouse Electric Corporation, Philadelphia, Pa. 1955 ASME Spring Meeting paper No. 55—S-34 (multilithographed; to be published in Trans. ASME; available to Feb. 3, 1956).

IN THE gas-turbine field low-temperature corrosion problems occur at any point where exhaust gases contact cool surfaces as, for example, in the semi-closed cycle where it is necessary to cool the products of combustion through the dew point, extract the condensed water which was formed during combustion, and then return the gases to the low-pressure compressor.

Another application in which dew-point corrosion is likely to occur is in waste-heat recovery devices for gas turbines. Gas-turbine exhaust gases contain large amounts of energy at an initial temperature level of 700 to 800 F. These exhaust gases can be utilized to heat feedwater, to heat sea water for use in a flash evaporator which converts sea water into potable water, or to provide

preheated air for a conventional steam boiler. In each of these applications the exhaust gases contact cool surfaces and the danger of dew-point corrosion exists.

A series of corrosion tests are described in which it was found that the effects of this type of corrosion can be minimized by (*a*) use of certain corrosion-resistant alloys such as Hastelloy C, Carpenter No. 20, or Type 316 stainless steel; (*b*) the use of low-sulphur fuels; or (*c*) the maintenance of surface temperatures above the acid-water dew point.

Tests indicate that none of the presently available coating materials can provide adequate low-temperature corrosion protection for heat-exchanger surfaces or compressor blading.

Steam Power Generation

Torsional Vibration and Short Circuit of Marine-Geared Turbine-Generator Set, by B. M. Wundt and W. J. Caruso, Assoc. Mem. ASME, General Electric Company, Fitchburg, Mass. 1955 ASME Spring Meeting paper No. 55—S-47 (multilithographed; available to Feb. 1, 1956).

A GEARED turbine-generator set must be designed so that it will operate within acceptable limits for transverse and torsional vibration amplitudes. Transverse frequencies have received a great deal of attention and study in the past with the result that calculated frequencies can be closely correlated with actual frequencies, and machines can be designed with assurance that a transverse critical speed will not coincide with the operating speed. Similarly, balancing techniques have been developed to the point where transverse vibration due to unbalance may be readily minimized. This is not the case with torsional vibration of the rotating system. Methods are available to calculate torsional frequencies, but test data on actual high-speed geared sets are very scarce. This places a definite burden on the designer since he has no way of accurately predicting the actual torsional behavior of the set prior to its construction.

High amplitude torsional vibration at running speed may manifest itself in excessive gear wear with resultant noise, reflected vibration of stationary parts, or even failure of shafts or other rotating elements.

Torsional vibration amplitude measurements were made on a marine-geared turbine-generator set which had quill drive shafts of two different diameters installed for test. Measurements were made during normal running conditions and also while the three-phase generator was short-circuited.

Amplitude measurements were made over a range of speeds near resonance. Vibratory shear stresses in the quill drive shaft were derived relative to steady stresses due to driving torque.

Torsional response curves were plotted from which natural frequencies and apparent system damping were obtained. Comparison was made with calculated frequencies.

Amplitude measurements were made during application of a three-phase short circuit. The relation between the resultant peak stress in the quill shaft and the steady stress due to rated torque was indirectly determined and compared to the calculated value.

Materials Handling

Belt Conveyers for People, by E. L. Drake, Stephens-Adamson Manufacturing Company, Aurora, Ill. 1955 ASME Spring Meeting paper No. 55—S-33 (multilithographed; available to Feb. 3, 1956).

IN the past few years a great deal of interest has been shown in simple belt conveyers to be used as traveling sidewalks. Actually, there has been more written, more discussion, and more actual planning on the use of simple belt conveyers for people in the past few years than in the previous 50 years.

This paper describes the current use of belt conveyers for transporting people. It covers the use of simple and complex conveyer systems and mentions complex belt conveyers proposed in the past.

The system proposed for the movement of passengers from Grand Central Subway Station to the 42nd Street Times Square Station in New York City is described. Other installations in the planning stage are mentioned.

Process Industries

Is Chemistry in the Power Plant an Exact Science? by Frank U. Neat, Consolidated Gas Electric Light & Power Company of Baltimore, Baltimore, Md. 1955 ASME Spring Meeting paper No. 55—S-38 (multilithographed; available to Feb. 3, 1956).

OPINIONS about the art of feedwater and boiler-water chemistry can be divided into three classes. The first class believes that if water can be made pure enough, and kept pure, it is a suitable feedwater. The second class believes that it is not worth the effort to produce such pure water. This class treats the water with chemicals to render the impurities innocuous and to reduce ability of the water to dissolve metals. A third class is always hoping that someone will come along with a gadget which will cure all difficulties of the handling of water and production of steam from this water.

One of the prime reasons why power-station chemistry is misunderstood is that, when a paper is written discussing the benefits of any one chemical or system of chemicals in the power plant, while the truth may be told, it is seldom that the whole truth is told. In some cases this may be because the whole truth is not known. In other cases the whole truth is not told for publication but is conferred in confidence or in private. In either case a false impression is given to those who are not versed in the chemical arts. For instance, those who chemically treat do not make widely known troubles with hide-out, sampling, and testing. Nor do they admit to harmful chemical breakdown. On the other hand, those who practice no treatment do not make widely known their difficulties with tube failures nor do they treat the ammonia content of their steam as of any great importance.

This paper discusses different methods of handling and treating water and steam produced from the water. The paper takes up the caustic-embrittlement record, oxygen scavenging, pitting corrosion, ammonia in the system, the alkalinity argument, the subject of "hide-out," and acid-cleaning of boilers.

Management

New Developments Plus Know-How Equal? by J. W. Reid, Assoc. Mem. ASME, Design Engineering Corporation, Trenton, N. J. 1955 ASME Spring Meeting paper No. 55—S-13 (multilithographed; available to Feb. 3, 1956).

EXPANDING fields of engineering together with improvements in manufacturing are making it increasingly difficult to find any one person with the knowledge and experience required to guide an engineering and/or production project from inception to a successful completion. One solution to this problem, "the committee," approach is discussed. Its introduction, application, and general rules for its successful use are presented.

The paper lists the following values to be gained by establishing a design committee:

(*a*) It gives the wide background needed to solve many of today's problems in a practical manner.

(*b*) It enables management to diversify without losing any of the value of its years of experience.

(*c*) It keeps designs on the most profitable path both in creative thinking and economically.

(*d*) It keeps management well informed and gives individuals a better chance to be evaluated correctly.

(*e*) Cuts down liaison time between departments and shops.

(*f*) It can make the best use of specialized talents.

(*g*) When properly conducted it will strengthen any group by developing teamwork.

Evaluating Intangibles for Executive Decisions, by A. L. Stanly, Associated Missile Products Corp., Pomona, Calif. 1955 ASME Spring Meeting paper No. 55—S-28 (multilithographed; available to Feb. 3, 1956).

MAKING decisions to be used in planning procedures for highly complex activities is particularly difficult because of the need to balance intangible factors which cannot be readily evaluated numerically. Many of these intangibles are simply improbables; i.e., are large in magnitude but of infrequent chance occurrence. These items can be assessed for order of magnitude by determining their "expected cost"; i.e., the estimated cost of the event times the estimated probability of occurrence. Comparisons of expected costs can, however, frequently provide a relatively firm basis for decision even though the basic information may be highly uncertain and subject to wide variations in estimated magnitude.

In exemplifying the application of the expected-cost principle, an analysis is presented of the cost of the unreliability of guided missiles, losses concerned with alternate methods of military supply, and the cost of an explosion.

Aviation

Refueling in Flight for Air Defense, by J. H. Sidebottom, Flight Refueling, Inc., Baltimore, Md. 1955 ASME Spring Meeting paper No. 55—S-46 (multilithographed; available to Feb. 3, 1956).

FLIGHT refueling is coming into increasing prominence in both Air Force and Naval strategic and tactical operations—but as yet has not been applied to the problem of air defense. In this paper the author suggests various ways in which flight refueling may be employed to give defending aircraft greater range, mobility, endurance, and economy of operation.

This paper reviews the major defense missions of both the Air Force and the Navy, illustrates them with potential flight-refueling missions, and reviews some types of aircraft involved and their potentialities as tankers or receivers. Finally, the paper mentions briefly the different types of refueling systems in production or soon to be available.

Aerial Refueling With the Boeing Flying Boom, by R. P. Person, Boeing Airplane Company, Seattle, Wash. 1955 ASME Spring Meeting paper No. 55—S-50 (multilithographed; available to Feb. 3, 1956).

THE value and justification of an aerial-refueling system can be condensed into one word—range. Some of the ways in which this asset can be exploited to increase the military effectiveness of the airplane performing the primary mission, in the case of a given receiver airplane, are as follows:

1 The distance obstacle can be reduced, making deeper penetration of enemy territory possible, or operations can be conducted from remote bases less susceptible to enemy attack.

2 Endurance can be increased tremendously, to the point, in fact, where crew endurance becomes the critical factor.

3 Attrition due to combat action or operational hazards can be reduced, since enemy territory can be penetrated under more advantageous conditions of speed, altitude, approach path, and airplane vulnerability. The "straggler pickup" technique can be employed to rescue aircraft whose range has been compromised by weather, navigational error, combat damage, or operational failure.

4 Pay load can be increased, or aircraft can operate from smaller or less well developed airfields than would be possible without refueling.

5 Mobility can be substantially augmented.

This paper deals with the development of the Boeing Flying Boom aerial-refueling method from its inception in 1948 until the present time. Underlying reasons for the emphasis placed on aerial refueling are considered, fundamental design objectives and operating principles of the Flying Boom are presented, and significant development and operation experiences with this system are reviewed.

Zero-Length Launch for Matador, by C. J. Libby, The Glenn L. Martin Company, Baltimore, Md. 1955 ASME Spring Meeting paper No. 55—S-35 (multilithographed; available to Feb. 3, 1956).

ZERO-length launching is a method of launching whereby the rocket, missile, or plane is actuated as a ballistic body by some form of propulsion. At no time during the launching is the body mechanically guided. A vector diagram would show that the resultant velocity along the flight path begins as soon as the mass is in motion, or at zero distance along the flight path. At no time during the launching phase is the missile or airplane aerodynamically stable. This means of launching was selected to permit the minimizing of the area required for take-off.

Rocket attachment to missile is accomplished by means of a head-end fitting to receive the rocket-ejection fitting and two fittings of the missile tail. The forward fitting is designed to take the full rocket thrust, whereas the two rear fittings are for stabilizing purposes only. All three fittings are of the open-fork and bolt type.

The booster rocket is separated from the missile and the launcher by compressed air. The forward rocket attachment is actually a compressed-air cylinder. It is precharged at the squadron ordnance area. The cylinder is prevented from separating prematurely by two undercut shear bolts.

When the rocket is ignited, the bolts permit the "piston" of the rocket-nose attachment to further compress the air. When the thrust abates, the rocket is free to move backward and is assisted in this movement by the compressed air. This system has never been known to fail during a Matador launching.

Today's launcher is a specially modified semitrailer which weighs 34,000 lb. It is used primarily to elevate the TM-61 to its launching attitude and to support it in a retracted position for transportation over roads. It can either be hauled by a standard truck tractor or by using a standard dolly by conventional 6 × 6 truck.

In constructing the launcher a standard Fruehauf semitrailer is modified by the addition of the launching frame, the support mechanism, the hydraulic raising mechanism, a missile cooling system, an electrical system, an engine-start fuel system, and necessary storage and control compartments. Basically, these additions are composed of commercial-grade conventionally welded steel construction.

The missile rests on the launching frame at three points, two ball socket joints in front and a tail saddle. The missile is prevented from moving forward or aft during the raising and engine run-up prior to launch by a special bolt inserted between the missile tail and the rear saddle. This bolt shears when the rocket is ignited. The missile may then move forward. The forward supports are capable of moving forward and down. These are actuated by the motion of the

missile and are prevented from bouncing in the bottomed position by a pair of shock absorbers.

Today there have been over 200 Matador launchings by ARDC, TAC, and the Martin Company. During the seven-year testing period, there have been only two launching failures.

Instruments and Regulators

Determination of System Characteristics From Normal Operating Records, by T. P. Goodman, Assoc. Mem. ASME, and J. B. Reswick, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Instruments and Regulators Conference paper No. **55—IRD-1** (mimeographed; available to Feb. 3, 1956; to be published in Trans. ASME).

SOME new techniques are presented for experimentally determining the dynamical characteristics of linear systems. These techniques are based on analysis of random variations in the operating variables during the system's normal course of operation. Particular attention is paid to the effects of uncorrelated variations (noise) on the methods.

The use of the "delay-line synthesizer" as a device for discovering system characterizations is presented.

Results obtained for the determination of a transfer operator for a human being engaged in tracking a target are presented as an example of the effectiveness of the random-data-analysis approach.

Techniques presented for determination of system characteristics have proved their usefulness in a human-operator study and are now being applied in studies of process-control systems. Laboratory studies have shown that these techniques yield transfer operators which are comparable to those obtained from step-response and frequency-response measurements. These techniques will prove valuable in a wide range of problems in which it is not feasible to interrupt a system's normal operation.

Disturbance Response Feedback—A New Control Concept, by J. B. Reswick, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Instruments and Regulators Conference paper No. **55—IRD-2** (multilithographed; available to Feb. 3, 1956; to be published in Trans. ASME).

A NEW scheme of automatic control called disturbance response feedback is presented. A special form of this method utilizing a dynamic model of the plant in a feedback path is called plant model control. The classically difficult-to-control plant having a transfer operator consisting of pure delay (transportation lag or dead time) is shown to be brought under optimum control in an experimental study.

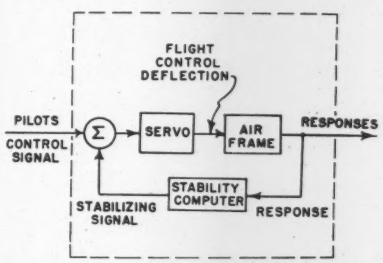
Disturbance response feedback requires for optimization the specification of only one parameter. It therefore provides a useful reference basis for evaluating other schemes. This is done for some simple systems of control. The plant model-control technique offers a possible basis for realizing a completely self-adjusting automatic controller.

Improving Airplane-Handling Characteristics With Automatic Controls, by C. L. Muzzey, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y. 1955 ASME Instruments and Regulators Conference paper No. **55—IRD-3** (multilithographed; available to Feb. 3, 1956; to be published in Trans. ASME).

THE modern high-speed airplane is one of the most important users of automatic-control systems. They are found all the way from small instrument repeater servos through engine power, temperature, or thrust controls, to fully automatic flight-control systems which direct the path of the airplane or missile with no human help whatsoever during part or all of its mission.

This paper describes an important mode of airplane flight in which the aircraft is under the joint control of a human pilot and an automatic-control system. The first part describes the interaction of air loads and inertia reactions which govern the dynamic stability of the airplane and seeks to give a physical picture of the airplane's response to control and random disturbances.

A research project is described in which the pilot's controls were disconnected from the control surfaces, and separate servos provided both to drive the aerodynamic surfaces and to resist the actions applied to the cockpit controls by the pilot. The surface servos receive signals from cockpit-control motions and from a stability computer which senses airplane-body motions. Airplane response as seen by the pilot can be varied by adjusting the computer, and the pilot is unaware of the control-surface motions caused by the computer. Thus both airplane stability and control feel can be varied independently and easily in flight. Research airplanes so equipped are now being used to map out regions of acceptability for future design in the handling-characteristics problem and are incidentally demonstrating means for stabilizing existing airplanes which may be deficient in one or more respects.



A block diagram of an airplane equipped with artificial stability. In so far as the pilot is concerned, the net response of the array of units within the dotted line is the airplane response. The action supplied by the automatic-control system has come to be known as "artificial stability" in contrast to the natural stability of the airframe alone.

Study of Pneumatic Processes in the Continuous Control of Motion With Compressed Air—I, by J. L. Shearer, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Instruments and Regulators Conference paper No. **55—IRD-4** (multilithographed; available to Feb. 3, 1956; to be published in Trans. ASME).

A PNEUMATIC servomotor consisting of a 4-way control valve and double-acting ram is analyzed to determine the effective use of this system for continuous control of ram motion. Special emphasis is placed on studying the dynamic behavior of the fluid in the ram chambers and the pressure-flow characteristics of the control valve.

Comparisons are made of the measured and theoretical characteristics of a typical control valve.

The results of a simple experiment with a control valve and tank determine the validity of the ram-chamber analysis.

A subsequent paper will show how the complete servomotor system, including mass load, is analyzed for its response to small changes of valve opening and to changes of external load force, and a simple electronic analog of the system is used to study means of providing adequate system damping.

Dynamic Analysis of Chemical Processes, by E. G. Holzmann, Shell Development Company, Emeryville, Calif. 1955 ASME Instruments and Regulators Conference paper No. **55—IRD-5** (multilithographed; available to Feb. 3, 1956).

IN the design of a new chemical plant certain questions arise to which past experience does not always give adequate answers. For example, what provisions must be made to insure stable control of a particular reaction? Can a critical temperature be held constant when

ambient conditions change? All too often the final answer to such questions is not found until trouble arises during start-up of a new plant.

Dynamic analysis offers a way to resolve some of these baffling questions in the design stage. As a result, trouble may be anticipated and costly down time reduced. Compared with the cost of delayed plant start-up, the effort required to predict difficulties and to eliminate them in the design stage is small.

This paper discusses the dynamic point of view as applied to chemical plants. To illustrate the methods currently used in analysis, attention is focused on the study of a typical example, a continuous catalytic reaction.

Improved Process Control From Noninteracting Controller Design, by D. P. Waite, Assoc. Mem. ASME, General Electric Company, West Lynn, Mass. 1955 ASME Instruments and Regulators Conference paper No. **55—IRD-6** (multilithographed; available to Feb. 3, 1956).

CONVENTIONAL process controllers of the three-term type, proportional-plus rate-plus reset, do not provide independent settings. One consequence is a limitation on the maximum value of the ratio of rate to reset coefficients.

This paper presents the results of an investigation of linear systems, indicating that a ratio value above this limit will in some cases result in significant improvements in system response to disturbances.

It is concluded that such higher values as are required may be obtained from a noninteracting controller design.

Control of Surge in Centrifugal Compressors, by G. J. Fiedler and T. F. McGrath, Sverdrup and Parcel, Inc., St. Louis, Mo. 1955 ASME Instruments and Regulators Conference paper No. **55—IRD-7** (multilithographed; available to Feb. 3, 1956).

SYSTEMS-ENGINEERING principles are applied to the design of surge control for several large compressors which operate in series to supply high-pressure air for a plant having a widely varying demand both in pressure and volume flow.

Surge control is necessary to prevent damage to the equipment and to hold pressure and flow to the high-accuracy requirements of the system. Surge control is accomplished by means of a control valve employed with each compressor in order to by-pass the required amount of air around the compressor when the demand falls below the "critical-flow" point on the compressor characteristic.

This paper presents the results of an analytic and analog study of the problem for one compressor-and-surge valve combination.

The compressor system is analyzed using standard frequency-response methods supplemented by the electronic analog computer. The transfer functions are derived from basic thermodynamic relationships using the small perturbation method of linearization. The relationships are expressed operationally and the coefficients are evaluated for this particular compressor. The control-loop block diagram is drawn and the basic control-valve requirements are evolved. Valve equations are derived and their corresponding physical counterparts are described. It is demonstrated that these requirements cannot be met by presently available commercial-valve designs. Valve dynamics are presented and their relation to system cost and performance are demonstrated. Valve characteristics are shown to be dependent on the characteristics of the compressor.

The system-analysis methods used may be applied to any process equipment and the valve which regulates its action.

Evaluation of the Nonlinear Kinetic Behavior of a Nuclear Power Reactor, by R. C. Howard, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Instruments and Regulators Conference paper No. **55—IRD-8** (multilithographed; available to Feb. 3, 1956; to be published in Trans. ASME).

THE transient response of a nuclear reactor system can be extremely difficult to determine by analytical methods. Frequently, recourse must be made to a computational device if a complete description of the system is to be obtained.

In this study, an analog computer was employed to investigate the transient behavior of a sodium-cooled, graphite-moderated heterogeneous reactor and its primary-loop heat exchanger. The two-fold purpose of the study was to analyze this particular reactor system and to obtain a general evaluation of the errors that result from the simplifying assumptions often made to solve reactor transient problems.

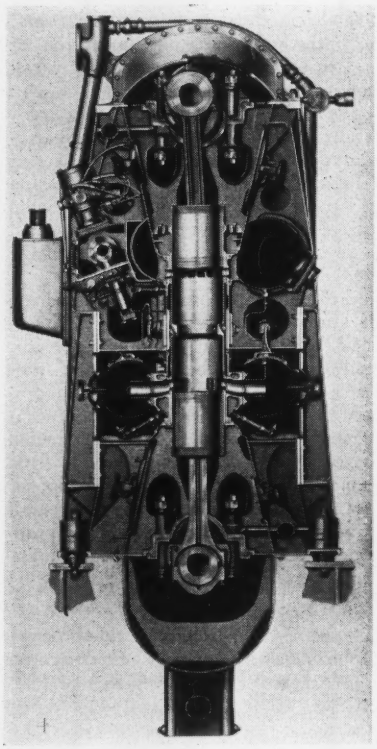
The most important result of the study is the demonstration of the inherent short-term stability of this type of reactor and the long-term transient instability that results unless external control is employed.

Oil and Gas Power

The Development of a High-Speed, Lightweight Opposed-Piston Engine for Submarine Application, by A. K. Antonsen, Mem. ASME, Fairbanks, Morse & Company, Beloit, Wis. 1955 ASME Oil and Gas Power Conference paper No. **55—OGP-9** (multilithographed; available to April 1, 1956).

THE author's company has built opposed-piston diesel engines for the U. S. Navy for 20 years. This engine is designed around the two-crankshaft principle. The lower crankshaft is connected to the exhaust pistons which control the opening and the closing of the exhaust ports. The upper crankshaft is connected to the air pistons which control the opening and closing of the air-intake ports. The two crankshafts are timed together in proper relationship by means of gears.

During the years 1947 and 1948, after



A cross section of the assembled opposed-piston engine. In accordance with established practice this engine has dual integral air receivers with interconnected passages surrounding the intake ports at the upper end of the cylinder and dual removable exhaust manifolds with directional exhaust deflectors near the lower end of the cylinders. From the cross section it can be seen that both upper and lower main bearings are held together by means of fitted through-bolts.

completing a total number of nearly 2000 of the $8^1/_8 \times 10$ opposed-piston engines, there appeared to be a need for engines of similar hp rating per cylinder but of a weight specification of only 40 per cent of the previous weight per hp.

The paper gives an account of the development of this new engine.

Air-Force Requirements for Diesel Engines, by J. S. Bleymaier, U. S. Air Force, Air Research & Development Command, Baltimore, Md. 1955 ASME Oil and Gas Power Conference paper No. **55—OGP-11** (multilithographed; available to April 1, 1956).

FEW people associate diesel engines with the Air Force. Usually they think of the Air Force in terms of aircraft engines such as jet, ramjet, and rocket engines. Actually this Service is a fairly large user of diesel engines.

This paper deals primarily with Air-Force qualitative requirements for diesel engines. However, an indication of the quantitative requirements is given as well as some of the more important applications of diesel engines within the Air Force.

The Air Force has requirements for diesel engines ranging from 30 to 3500 hp. Largest application of diesel engines in the Air Force is as prime movers for portable engine-generator plants for power generation (60 cycle, 3 phase, 4 wire 120/208 or 254/440 volts). Over 7400 portable diesel engine-generator plants are in the Air-Force inventory.

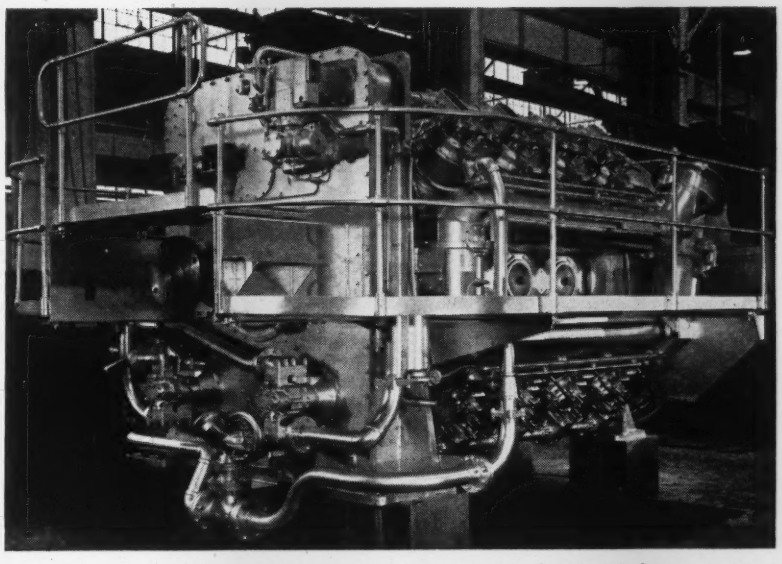
Development of a Large Two-Cycle Gas Engine, by E. R. Brater, General Motors Corporation, Cleveland, Ohio. 1955 ASME Oil and Gas Power Conference paper No. **55—OGP-6** (multilithographed; available to April 1, 1956).

ECONOMIC reasons for the development of large gas engines, based on the availability of an abundant supply of relatively cheap natural gas, are outlined.

A description is given of the various phases of the design, and the engineering features of a two-cycle, loop-scavenged, gas engine developed by the author's company.

After experimentation with a 4-cylinder, horizontal, "Vee" type engine, it was concluded that a radial-type 16-cylinder engine would be a desirable design for the service required.

This engine can be direct-connected to standard speed increasers or reduction gears to drive centrifugal compressors or petroleum pumps. With attached accessories, much power-station piping is eliminated which results in a high-powered, compact, and rugged installation. For aluminum-reduction plants it can be direct-connected to a generator.



General view of $12^1/_2 \times 14^1/_2$, two-cycle, loop-scavenged, 16-cylinder gas engine

The engine is normally rated 3300 bhp at 600 rpm. The bore is $12^1/_2$ in. and the stroke $14^1/_2$ in. The engine is spark-ignited and uses natural gas as a fuel.

Standardization of Marine Diesel Engines, by C. A. Peterson, U. S. Naval Experiment Station, Annapolis, Md., and W. M. Howerton, U. S. Navy, Bureau of Ships, Washington, D. C. 1955 ASME Oil and Gas Power Conference paper No. **55—OGP-2** (multilithographed; available to April 1, 1956).

THE multiplicity of makes and models of diesel engines installed in Navy ships and craft created a critical logistics and maintenance problem in the U. S. Navy during World War II. This situation was again evidenced at the beginning of the Korean engagement. Since it substantially reduces the combat potential and effectiveness of the Fleet, a satisfactory solution to the problem is urgent. The obvious need is for standardization. The method of achieving it is subject to discussion and determination.

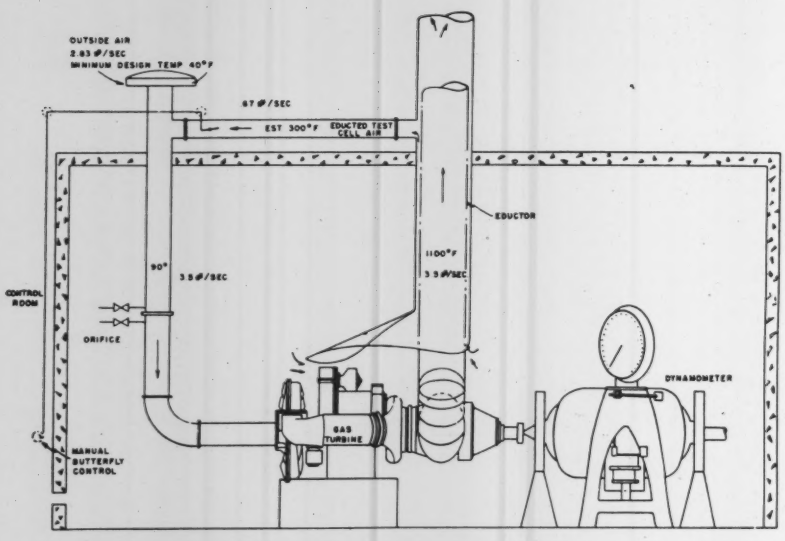
Standardization of Navy marine diesel engines should result in ship and craft installations which, on an over-all basis, have the practical minimum number of engine models, with the maximum interchangeability of parts consistent with optimum performance for the specific conditions of use and with maintaining reasonable competition and adequate sources of supply.

This paper presents the need for standardization of marine diesel engines installed in ships of the U. S. Navy, discusses various approaches to the problem, and makes specific recommendations as to the most practical and effective way to achieve the desired objective.

A policy for working-level guidance in implementing the recommended approach is proposed.

Fuels for U. S. Navy Gas Turbines, by H. F. King, U. S. Navy Department, Bureau of Ships, Washington, D. C., and H. V. Nutt, U. S. Naval Engineering Experiment Station, Annapolis, Md. 1955 ASME Oil and Gas Power Conference paper No. **55—OGP-8** (multilithographed; available to April 1, 1956; to be published in Trans. ASME).

ANY plan of gas-turbine employment in the Navy would naturally include consideration of the type of fuel to be burned. Thus, up to the present time, Naval consideration of gas turbines has been on the basis of using either diesel fuel or Navy special fuel. Basically, all turbines under development are intended for the use of diesel fuel in the event no other fuel is suitable. Small high-speed gas turbines of the auxiliary type are applied in locations and operated in a manner which precludes the use of anything except a relatively volatile, nonviscous, easily burned fuel of the distillate type, similar to diesel fuel. This is also true of turbines for small-craft propulsion. But in booster turbines used with steam power plants, the possibility of using other than diesel fuel, i.e., residual



Installation for testing fuels. The gas turbine was installed in a test cell and coupled to a dynamometer. The high velocity of the exhaust gas was used in an eductor to ventilate the test cell. The warm test-cell air was further heated as it passed over the outer periphery of the exhaust stack. A portion of this air was blended with outside air to regulate the temperature of the inlet air to the gas turbine. For convenient year-round operation, a controlled inlet temperature of 90 F was selected. This furnished a simple and economical method of maintaining a constant-temperature air supply to the gas turbine for the different fuel runs.

fuels and lower-grade distillates, is being explored extensively.

The U. S. Navy presently requires considerable quantities of diesel and Navy special fuels for shipboard applications.

To insure that no serious problems would be encountered in the application of diesel fuels to auxiliary-type gas turbines, an investigational program was initiated at the U. S. Naval Engineering Experiment Station, Annapolis, Md. In this program, tests were made to determine whether a typical small, high-speed, open-cycle-type gas turbine would operate successfully with fuels covering the entire range of properties procurable under the Military Marine Diesel Fuel Specification MIL-F-16884 (SHIPS).

The Analysis of Development Trends in Industrial Diesel Power Units, by C. G. A. Rosen, Fellow ASME, Caterpillar Tractor Company, Peoria, Ill. 1955 ASME Oil and Gas Power Conference paper No. **55—OGP-13** (multilithographed; available to April 1, 1956).

THIS paper discusses some significant factors which can contribute to an improved market acceptability of industrial-type diesel engines: (*a*) By improving its cyclic performance, and (*b*) by broadening the range of usable fuels. In the future, these two important objectives will occupy a more prominent place in the advancement of the high-output diesel engine.

Aerothermodynamic Considerations Involved in Turbocharging Four and Two-Cycle Diesel Engines, by R. Birmann, Mem. ASME, DeLaval Steam Turbine Company, Trenton, N. J. 1955 ASME Oil and Gas Power Conference paper No. **55—OGP-10** (multilithographed; available to April 1, 1956; to be published in Trans. ASME).

THE turbocharged engine is, in effect, a compound engine in which the engine itself handles the high-pressure end of both compression and expansion, while the exhaust-turbine-driven compressor takes care of the low-pressure end. The turbocharger pressure ratio determines the division of work between high-pressure and low-pressure components, and the value of this pressure ratio governs, to a large extent, the values of all engine-performance variables.

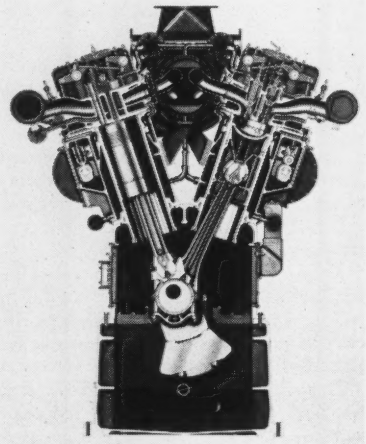
In this paper the interrelationships between all of these variables are discussed. Curves are presented giving numerically the interdependence, one on the other, of turbocharger pressure ratio, thermal loading, specific-fuel consumption, and turbocharger combined efficiency, with and without intercooling. The aerothermodynamic situation of the two-cycle engine is treated separately, with emphasis on the all-important flow-handling ability of the engine. This ability is defined by the concept of the "gas change process merit ratio," and, by means of a series of curves, the specific engine air flow is given for different merit ratios and different turbocharger combined efficiencies for a range of turbocharger pressure ratios.

Finally, for both two-cycle and four-cycle engines, the importance of good matching between engine air-consumption characteristics and turbocharger air-delivery characteristics is discussed, and as a criterion for this matching the engine operating line, as it appears superimposed on the compressor characteristics curve, is used.

The Philosophy of the V-Engine, by R. L. Boyer, Mem. ASME, and J. W. Holmes, The Cooper-Bessemer Corporation, Mount Vernon, Ohio. 1955 ASME Oil and Gas Power Conference paper No. **55—OGP-7** (multilithographed; available to April 1, 1956).

DURING recent years the progress of the internal-combustion engine has been in the direction of higher unit output with increased economy. The rise of the V-engine popularity has been a significant part of this development. Although many other cylinder configurations have been conceived with these objectives in mind, the V-engine has demonstrated superiority in mechanical design, ease of maintenance, and space requirements.

This paper discusses design problems, weight reduction, applications, locomotive service, natural-gas engines, the



Cross section of sixteen-cylinder stationary V-engine of 15½-in. bore and 22-in. stroke

radial engine, radial-engine application, maintenance problem, and installation costs.

The Comparison of the Fatigue Characteristics of New and Used Crankshafts, by J. L. Ciringione, New York Naval Shipyard, Brooklyn, N. Y. 1955 ASME Oil and Gas Power Conference paper No. **55—OGP-5** (multilithographed; available to April 1, 1956).

THE objective in this study was to determine the influence of stress history on the endurance limit, and the S-N relationship of full-scale diesel-engine crankshafts when subjected to pure torsional and bending stresses.

A description is given of the apparatus used including an automatic stress control.

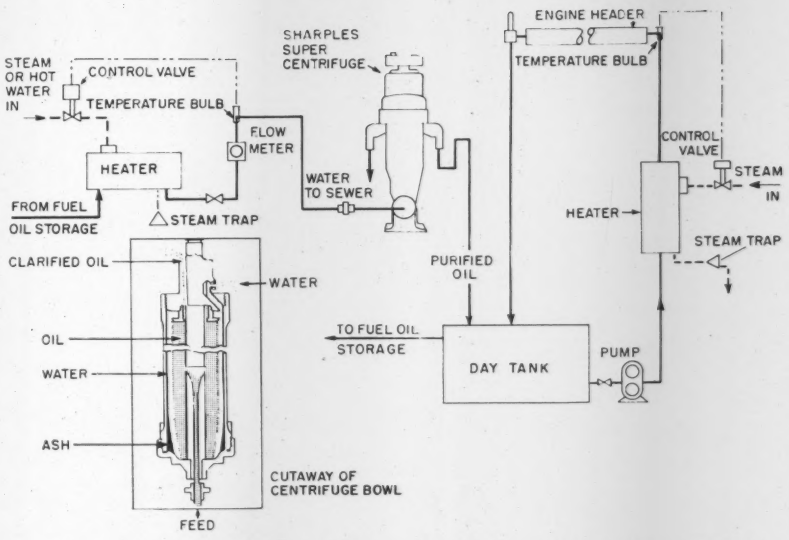
In order to reduce the number of specimens in succeeding investigations of this type of crankshaft, a method of statistical analysis is proposed.

It is concluded that new and used crankshafts are equivalent in so far as the fatigue characteristics are concerned. In fact, in the case of the torsional tests, the used shafts exhibit a higher endurance limit than do the new crankshafts. This is very likely due to the effects of cold-working as a result of operation in service. It is believed that these crankshafts, in normal engine operation, are subjected to torsional stresses which, although appreciable, are well below the endurance limit; therefore the beneficial effects are apparent.

As a result of this investigation, other studies into the fatigue characteristics of crankshafts, particularly as applied to salvage procedures, are being conducted presently utilizing as crankshaft specimens used crankshafts of this type.

The Preparation of Residual Fuel for Motive Power, by F. H. Smith, Mem. ASME, and F. P. Downing, The Sharples Corporation, Philadelphia, Pa., and J. T. Costigan, Mem. ASME, The Sharples Corporation, New York, N. Y. 1955 ASME Oil and Gas Power Conference paper No. **55—OGP-1** (multilithographed; available to April 1, 1956).

RESIDUAL fuel is the by-product which remains after very careful control of the process for extracting specification products from crude petroleum. Since crude oils vary quite widely in composition, it follows that the residue which remains after extracting benzene, gasoline, kerosene, and distillate fuels, all of which are standard in analysis, must in itself be of nonuniform analysis. In fact, this variation will be much greater than in the larger volume of crude petroleum oil. Specific analyses of residual fuel from many companies have been reported in numerous papers showing its widely varying physical properties and chemical composition. The problem, therefore, which faces the industry in the proper utilization of residual fuels for diesel engines and gas turbines is to find a means for reducing this variable by-product down to a standard useful fuel. The final product must be capable of operating the engine or turbine at peak efficiency without significantly increasing maintenance costs and do this on the residuals which are available to the American consumer.



Typical layout of residual-fuel centrifuge-purification system for diesel engine

Residual fuel must be subjected to one or more of the following purification steps, depending on source of supply and end use:

1 If the residual fuel is wet from storage or tank leakage, the water must be removed. This is particularly important in marine use, but is seldom a problem at a carefully operated land-based power plant.

2 Carboid solids, either with or without asphaltenic coatings, must be removed. This is extremely important in the case of diesel engines where clearances are very small and long-range maintenance is important.

3 Asphaltenic agglomerates should be separated from the carboid nucleus and redispersed in the oil in a state as nearly colloidal as possible. This is important for any use where economies of operation are critical.

4 For turbine use, water-soluble minerals must be removed by water washing to reduce corrosion on the turbine blades.

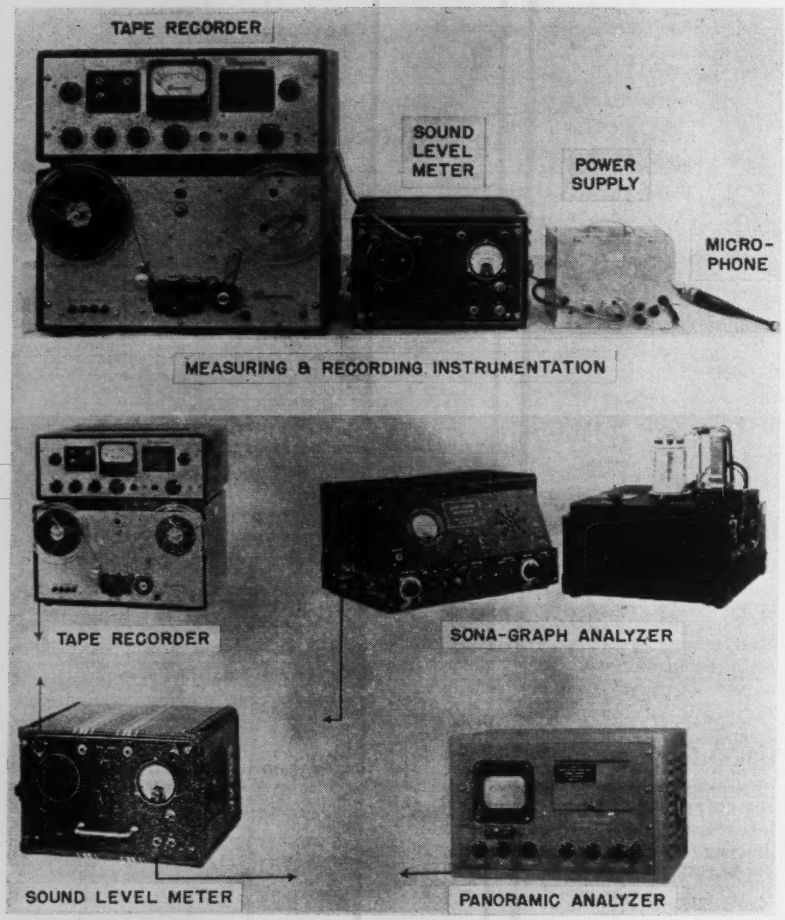
This paper shows how these purification and preparation steps are accomplished.

Cetane Improver Additives for Diesel Fuels, by W. H. Hubner, Ethyl Corporation, New York, N. Y. 1955 ASME Oil and Gas Power Conference paper No. **55—OGP-12** (multilithographed; available to April 1, 1956).

A REMARKABLE increase in the use of diesel power has occurred during the past 14 years. This has resulted in a substantial demand for diesel fuel—a demand which has increased sixfold since 1941 compared to a twofold increase for gasoline, the principal petroleum product. To achieve the cetane requirements with available diesel fuels, additives are needed. After exhaustive research, DB-36 amyl nitrate was found to be effective in all types of diesel fuels, regardless of crude source, sulphur content, or refining technique. The paper reviews this development in some detail.

Analysis of the Basic Noise Sources in the Diesel Engine, by K. R. Mercy, New York Naval Shipyard, Brooklyn, N. Y. 1955 ASME Oil and Gas Power Conference paper No. **55—OGP-4** (multilithographed available to April 1, 1956).

A TYPICAL two-cycle diesel engine was studied to obtain information as to the cause of high-level noise. With electronic instrumentation and without the aid of a costly anechoic chamber, the complete engine and various engine



Instruments utilized in conducting noise investigations. Noise measurement and recording instrumentation consisted of a condenser-type microphone, sound-level meter, and a magnetic-tape recorder. All tape recordings were monitored by the sound-level meter so that absolute noise levels could be evaluated during the playback. The analyzing instruments consisted of a sound-level meter, magnetic-tape recorder, and several analyzers.

assemblies were analyzed by their frequency spectrums. The combustion cycle was studied to determine its contribution to the over-all engine noise.

Noise propagation, transmission, and radiation were discussed so that a better knowledge of the noise problem may assist engineers in the direction of efforts toward designing quieter engines or reducing noise in existing engines.

Sources of noise in a 2-cycle engine were identified as the scavenging blower, pistons and connecting rods, exhaust valves and injectors. Combustion noise was not identified as an important noise factor.

Noise reduction and control are possible by attacking the noise sources but the greatest accomplishment can best be made by employing noise-control fundamentals in the stage design.

Effect of Size on the Inlet-System Dynamics in Four-Stroke, Single-Cylinder Engines, by D. H. Tsai, National Bureau of Standards, Washington, D. C. 1955 ASME Oil and Gas Power Conference paper No. 55—**OGP-3** (multilithographed; available to April 1, 1956; to be published in Trans. ASME).

THE problem of dynamic similarity in the inlet systems of four-stroke, single-cylinder engines was brought out in a recent paper by Taylor, Livengood, and Tsai. In that paper, a similarity rule applicable to engines of different sizes, and with different bore-to-stroke ratios, was formulated from theoretical considerations.

This paper examines this similarity rule in greater detail and evaluates the theory in the light of experimental data recently obtained at the Engines and Lubrication Laboratory at the National Bureau of Standards, Washington, D. C. The discussion is limited to inlet systems with long inlet pipes.

Applied Mechanics

Influence of Secondary Inertia Terms on Natural Frequencies of Rotating Beams, by J. L. Bogdanoff, Mem. ASME, Purdue University, Lafayette, Ind. 1955 ASME Applied Mechanics Conference paper No. 55—**APM-17** (in type to be published in the *Journal of Applied Mechanics*).

THE equations of small motion of a straight cantilever beam attached to the rim of a rotating disk are determined assuming the Bernoulli-Euler theory of bending and the Saint Venant theory of torsion are valid, the mass and elastic axes coinciding and retaining all inertia terms. Influence of the secondary inertia terms on the fundamental torsional and lateral frequencies is then examined at two angular settings for a uniform beam having a length-to-disk-radius ratio in the range usually encountered in gas-turbine buckets and axial-flow compressor blades.

Nonlinear Dynamic Coupling in a Beam Vibration, by P. H. McDonald, Jr., North Carolina State College, Raleigh, N. C. 1955 ASME Applied Mechanics Conference paper No. 55—**APM-23** (in type; to be published in the *Journal of Applied Mechanics*).

THIS investigation treats the vibration of a uniform beam with hinged ends which are restrained, and which has arbitrary initial conditions of motion. A representative example is discussed in which the beam is subjected to a concentrated lateral force at the mid-point of its span and released from rest at the deflection position.

The equations of motion are found to be inherently nonlinear, even for small vibrations, and there is dynamic coupling of the modes. It is found that the frequencies of the various modes are functionally related to the initial conditions, particularly the amplitudes of all the modes.

Some Solutions of the Timoshenko Beam Equations, by B. A. Boley and C. C. Chao, Institute of Air Flight Structures, Columbia University, New York, N. Y. 1955 ASME Applied Mechanics Conference paper No. 55—**APM-28** (in type; to be published in the *Journal of Applied Mechanics*).

SOLUTIONS are obtained by the method of Laplace transformation for four types of loadings applied to a semi-infinite beam. Numerical results are presented

for two of these, both for suddenly applied and gradually varying loads. The effects of shear deformations and rotatory inertia are taken into account according to Timoshenko's beam model.

A comparison with the corresponding results of the Bernoulli-Euler theory are briefly presented.

Complex Variable Method for Synthesis of Four-Bar Linkages, by N. Rosenauer, New South Wales University of Technology, Sydney, Australia. 1955 ASME Applied Mechanics Conference paper No. **55—APM-7** (in type; to be published in the *Journal of Applied Mechanics*).

In the design of four-bar linkages for prescribed instantaneous values of angular velocity and angular accelerations of particular links, the exponential interpretation of vectors is of great use. The idea was first given by S. Bloch in 1940 and later simplification and improvement were made by R. Beyer in 1943 and 1953.

A paper on a particular problem of designing a linkage with prescribed maximum and minimum values of output angular velocity was published by the author. This paper gives the fundamentals of the basic method as improved by the author.

An Approximate Nonuniform Bending Theory and Its Application to the Swept-Plate Problem, by H. J. Plass, Jr., The University of Texas, Austin, Texas. 1955 ASME Applied Mechanics Conference paper No. **55—APM-6** (in type; to be published in the *Journal of Applied Mechanics*).

Because of certain aerodynamic advantages, modern high-speed aircraft have been equipped with swept-back wings. Analysis of the deformation of such structures under given loads is very difficult unless certain simplifying assumptions are made. Recent studies on this problem have been carried out at the California Institute of Technology in which the swept wing is idealized as a flat homogeneous isotropic plate having the same plan form as the wing. In this study, both theoretical and experimental values were obtained for the deflection under various kinds of static loading. The theoretical phase of the study is based on plate theory and predicts values of deflection which are consistently too large.

In this paper the assumption is made that the wing can be idealized as a homogeneous isotropic prismatic bar having the same cross section as the wing.

Differential equations and boundary conditions are derived, by means of the calculus of variations, for cylindrical bars in nonuniform bending. The resulting equations are used, together with similar nonuniform torsion equations, to obtain deflections and stresses in swept cantilever plates of uniform rectangular cross section.

Comparisons are made with experimental results for plates with four different sweep angles. The theory predicts deflections quite close to those found experimentally. Stresses computed from the equations, however, are not in as close agreement. It is also noticed that the theory is less accurate for large sweep angles than for small ones.

Forced Vibration of a Clamped Rectangular Plate in Fluid Media, by Gordon C. K. Yeh, Assoc. Mem. ASME, and Johann Martinek, Reed Research, Inc., Washington, D. C. 1955 ASME Applied Mechanics Conference paper No. **55—APM-24** (in type; to be published in the *Journal of Applied Mechanics*).

Forced vibration of a thin rectangular plate clamped in a rigid infinite baffle is analyzed. The plate is assumed to separate two different fluid media and the vibration is excited by a simple plane wave of high frequency normally incident from one side of the plate. Using the characteristic shape functions, the Lagrange equations of motion of the plate are set up in generalized co-ordinates.

The solutions of the equations render series expressions for the plate deflection and an energy-transmission coefficient.

Certain numerical results are given.

The Extended Theory of the Viscous Vibration Damper, by F. M. Lewis, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Applied Mechanics Conference paper No. **55—APM-3** (in type; to be published in the *Journal of Applied Mechanics*).

The theory of the viscous vibration damper, tuned or untuned, has so far been developed only in application to a single-degree-of-freedom system. The majority of engine applications are of many degrees of freedom, and some of these depart so far, even in approximation, from a single-degree-of-freedom system, that the theory gives but little clue to the optimum damper characteristics.

A common type of installation, for example, consists of a multicrank engine, a flywheel, and a driven generator. In many cases, the important mode of vibration will approximate to the vibration of a two-mass system, engine plus flywheel constituting one mass, and the generator the other. It may be advantageous to fit a damper to the generator end of such an arrangement. The solution of this case is obviously remote from that for the single-degree-of-freedom-plus-damper system, and a damper designed to reduce the amplitude of the criticals in the engine shaft would be entirely inadequate to reduce the criticals between flywheel and generator.

This paper extends the theory of the viscous vibration damper either tuned or untuned to multimass systems and shows how an optimum damper can be designed for any installation. Special formulas are derived for the two-mass-plus-damper systems.

Buckling of Laminated Columns, by L. G. Clark, Assoc. Mem. ASME, University of Michigan, Ann Arbor, Mich. 1955 ASME Applied Mechanics Conference paper No. **55—APM-18** (in type; to be published in the *Journal of Applied Mechanics*).

A theory is developed to determine the buckling of laminated columns composed of two or more laminations and riveted or fixed together at certain points along the column. The laminations can be of different size and material but must be long in comparison to the cross-sectional dimensions.

The final result is presented in a form suitable for easy application. It is shown that for two laminations joined at an infinite number of points the problem reduces to that of a simple column.

Two pinned-end columns were tested and the results are in satisfactory agreement with the theory.

Free Vibrations of Thin Cylindrical Shells Having Finite Lengths With Freely Supported and Clamped Edges, by Yi-Yuan Yu, Assoc. Mem. ASME, Syracuse University, Syracuse, N. Y. 1955 ASME Applied Mechanics Conference paper No. **55—APM-13** (in type; to be published in the *Journal of Applied Mechanics*).

Free vibrations of thin cylindrical shells having finite lengths are investigated on the basis of a set of three differential equations which are derived in a similar manner as Donnell obtained his equations for the bending and buckling problems. The equations can be solved readily after a simplifying assumption is introduced. In this manner the frequency equations are obtained for cylindrical shells with both edges freely supported, with both edges clamped, and with one edge freely supported and the other edge clamped.

It is found that the lowest frequency given by the frequency equation is the smallest in the first case, larger in the

third, and the largest in the second. The other two frequencies yielded by the frequency equation are approximately the same in all cases. As a result of the approximations, the characteristic equations for the three cases are found to be similar to the frequency equations for the lateral vibration of beams with similar end conditions.

For the case of freely supported edges the normal functions obtained are identical in form with those assumed by Flügge and by Arnold and Warburton. For the same case, natural frequencies of one numerical example are computed by means of the present method, and the results are in good agreement with those obtained by these previous authors.

Thin Circular Conical Shells Under Arbitrary Loads, by N. J. Hoff, Mem. ASME, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1955 ASME Applied Mechanics Conference paper No. **55—APM-29** (in type; to be published in the *Journal of Applied Mechanics*).

EQUATIONS defining the displacements of the median surface of a conical shell under arbitrary loads are developed. In their derivation only the essential parts of the strain energy are considered and three simultaneous partial differential equations are obtained through the use of the variational calculus. When the minimum radius of curvature of the median surface of the cone is made to approach a constant value, the cone goes over into a cylinder. At the same time the equations here developed for the cone are transformed into the Donnell equations of the theory of cylindrical shells.

It is shown how eigenfunctions of the homogeneous equations can be constructed and how particular solutions can be found for any arbitrary loading.

On the Nonlinear Oscillations of Visco Elastic Plates, by A. Cemal Eringen, Purdue University, Lafayette, Ind. 1955 ASME Applied Mechanics Conference paper No. **55—APM-15** (in type; to be published in the *Journal of Applied Mechanics*).

EQUATIONS of motion of the three-dimensional finite oscillation theory are integrated across the plate thickness to obtain a second-order theory of oscillations for plates. For this purpose, components of the displacement vector are assumed to have power-series expansions in the transverse co-ordinate, and a systematic perturbation procedure in a non-dimensional thickness parameter is used. Stress-strain relations include the hereditary damping.

Simplified Formulas for Boundary-Value Problems of the Thin-Walled Circular Cylinder, by Frederick V. Pohle and S. V. Nardo, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1955 ASME Applied Mechanics Conference paper No. **55—APM-9** (in type; to be published in the *Journal of Applied Mechanics*).

N. J. HOFF has presented formulas which can be used in the solution of boundary-value problems of circular cylinders. This paper expresses these results in exact simplified forms. A more detailed investigation appears elsewhere.

Thermal Stresses in Rectangular Strips—II, by J. S. Born and G. Horvay, Mem. ASME, Knolls Atomic Power Laboratory, General Electric Company, Schenectady, N. Y. 1955 ASME Applied Mechanics Conference paper No. **55—APM-4** (in type; to be published in the *Journal of Applied Mechanics*).

STRESSES and deformations in rectangular strips due to various longitudinal temperature distributions are presented in formulas, tables, and graphs. The results are important for slabs, plate assemblies, rectangular ducts, and tube-sheet ligaments. They apply, in a more qualitative fashion, also to cylindrical bodies.

Stress Distribution in Square Plates With Hydrostatically Loaded Central Circular Holes, by A. J. Durelli, Assoc. Mem. ASME, and J. Barriage, Armour Research Foundation, Chicago, Ill. 1955 ASME Applied Mechanics Conference paper No. **55—APM-12** (in type; to be published in the *Journal of Applied Mechanics*).

THE stress distribution in square plates with hydrostatically loaded central circular holes was determined using photoelasticity and brittle coatings. Photoelasticity was used to determine the maximum shear lines (isochromatics) and a brittle coating was used to determine the directions of the principal stresses (isostatics).

The investigation was conducted for plates with holes producing seven ratios of the diameter to the square side (D/a). Curves are presented which show the distribution of the maximum shear stress along the axis and along the diagonal of the square plate, as a function of D/a. The maximum principal stress along the exterior and interior boundaries as a function of D/a, has also been given. A comparison is made of the stress ratios (σ_1/P) at a point on the axis of the square at the interior boundary with that calculated for a thick-wall cylinder using Lame's equation. Stress ratios (σ_1/P) also are determined for a point on the diagonal of the square plate at the interior boundary.

A diffused-light polariscope was used. The loading jig consisted of rubber tubing in a grooved block. The photoelastic material (CR39) was calibrated automatically.

No new methods are developed in the paper but it is felt that the use of the presently available methods has been simplified appreciably.

Force at Point in the Interior of a Semi-Infinite Solid With Fixed Boundary, by Leif Rongved, The Pennsylvania State University, University Park, Pa. 1955 ASME Applied Mechanics Conference paper No. **55—APM-14** (in type; to be published in the *Journal of Applied Mechanics*).

THE problem of a force at a point in the interior of a semi-infinite solid with free boundary has been solved by Mindlin. In the first of these papers Mindlin, starting with Kelvin's solution for a force in an infinite body, guessed the nuclei of strain to be added outside the region to satisfy the boundary conditions. In the second paper Mindlin showed how the solution may be obtained directly by an ingenious analysis applying potential theory. The same analysis is applied in this paper to solve the same problem, except that the boundary is assumed to be fixed.

The Papkovitch functions are determined for a force acting at a point in the interior of a semi-infinite isotropic solid with a fixed plane boundary. The normal traction on the boundary is then calculated.

Forced Vibrations of a Body on an Infinite Elastic Solid, by R. N. Arnold and G. B. Warburton, University of Edinburgh, Edinburgh, Scotland, and G. N. Bycroft, National Research Scholar of the Department of Scientific and Industrial Research, Wellington, New Zealand. 1955 ASME Applied Mechanics Conference paper No. **55—APM-10** (in type; to be published in the *Journal of Applied Mechanics*).

THE paper considers the forced vibration of a rigid body resting on a homogeneous elastic medium of infinite surface area and constant depth which may be finite or infinite. Four modes of vibration for a body with a circular base are investigated: (*a*) Vertical translation, (*b*) torsion, (*c*) horizontal translation, and (*d*) rocking.

For a semi-infinite medium the amplitude response can be obtained for any mass in terms of known constants of the system and two fundamental functions f_1 and f_2, which depend only on the exciting frequency and the properties of the medium. Close approximations to these functions have been evaluated for each

mode. Experiments on an elastic model are described, the results of which are in good agreement with theoretical prediction.

The behavior of a stratum of infinite area is more complex since functions f_1 and f_2 also depend on stratum depth. These functions have been evaluated for the torsional mode only, experimental results being given for the other modes.

Experiments Concerning the Yield Surface and the Assumption of Linearity in the Plastic Stress-Strain Relations, by P. M. Naghdi, Assoc. Mem. ASME, J. C. Rowley, and C. W. Beadle, Assoc. Mem. ASME, University of Michigan, Ann Arbor, Mich. 1955 ASME Applied Mechanics Conference paper No. **55—APM-5** (in type; to be published in the *Journal of Applied Mechanics*).

COMBINED tension and torsion experiments for six tubular 24S-T4 aluminum-alloy specimens with considerable initial anisotropy are reported.

From the experimental results it is clear that for the material tested the yield loci are not smooth. Furthermore, definite evidence of the existence of corners on the yield loci has been established. In view of this observed character of the yield loci, the validity of the assumption of linearity cannot be ascertained from the present or similar experimental results. It might be, however, that the assumption of linearity, together with the use of a singular yield condition, would correlate these results.

The Statistical Theory of Size and Shape Effects in Fatigue, by F. A. McClintock, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Applied Mechanics Conference paper No. **55—APM-25** (in type; to be published in the *Journal of Applied Mechanics*).

FATIGUE specimens are considered in which the stress amplitude is constant with respect to time but falls off parabolically along the length of the specimen from the point of maximum stress. From assumptions regarding the local variability in the strength of the material, equations are derived relating the scatter in cycles to failure to the scatter in position of failure. The effect of specimen size is determined for these two types of scatter, as well as for the average life.

It is found that the shape of the distribution function does not affect seriously the relation between scatter in cycles to failure and scatter in position of failure. The size effect, however, is markedly influenced by the shape of the distribution function.

A modification is suggested to make the results applicable to tests to determine the endurance limit, where the stress amplitude is a variable.

Combined Tension-Torsion Tests With Fixed Principal Directions, by E. A. Davis, Mem. ASME, Westinghouse Research Laboratories, East Pittsburgh, Pa. 1955 ASME Applied Mechanics Conference paper No. **55—APM-8** (in type; to be published in the *Journal of Applied Mechanics*).

A SERIES of combined tension-torsion-internal pressure tests, each with a different amount of torsion present, are discussed. The specimens were tested in such a manner that the principal directions of the increments of natural plastic strain were kept constant. These increments can be summed in various ways, the simplest of which would yield finite strains with fixed principal directions.

The octahedral shearing-stress versus octahedral shearing-strain diagrams for the four specimens tested coincide quite closely. The principal directions of stress were measured at each increment of strain and found to agree well with those of the increments of strain.

A Study of the Stability of Plane Fluid Sheets, by W. W. Hagerty, Mem. ASME, and J. F. Shea, Assoc. Mem. ASME, University of Michigan, Ann Arbor, Mich. 1955 ASME Applied Mechanics Conference paper No. **55—APM-21** (in type; to be published in the *Journal of Applied Mechanics*).

IN STUDYING the performance of a system for producing sprays of any kind it would be desirable to arrive at an expression which would relate the drop-size distribution and the spatial distribution of the drops in terms of the variables of the system including pressure, density, surface tension, and geometry.

In an earlier study of the performance of hollow-cone swirl-type nozzles, photographs were taken of the region where the fluid sheet breaks up into drops. These photographs showed that before the break-up occurred, waves or ripples appeared on the surface of the liquid sheet. It was believed that the waves were responsible for the break-up and that frequency and wave length of the ripples might be related to the size range of drops produced.

Difficulties were encountered in an analytical treatment of the stability of the surface produced by a swirl-type nozzle, the surface being a hyperboloid of revolution. Therefore a system was selected for study in which a flat sheet of fluid is produced by a slender orifice, and which may be subjected to waves of any desired frequency. This plane sheet, exposed on both sides, appears to have the essential characteristics of the sheet produced by a conventional nozzle.

Integral Methods in Natural-Convection Flow, by Salomon Levy, General Electric Company, Schenectady, N. Y. 1955 ASME Applied Mechanics Conference paper No. **55—APM-22** (in type; to be published in the *Journal of Applied Mechanics*).

THIS paper presents an evaluation of the range of application, accuracy, and usefulness of integral methods in natural-convection flow.

The study reveals that integral methods may be utilized to obtain approximate answers to free-convection problems whenever exact analytical solutions become too involved. Specific-flow examples considered here (natural convection from inclined plate, horizontal cylinder, arbitrary body, or within enclosed channels) confirm their adaptability to complicated configurations.

Over-all accuracy of the solutions is good. For inclined plates the derived equations reduce at high Grashof numbers to the correlation proposed and verified by Rich, while in the case of horizontal cylinders the results compare satisfactorily with the theoretical values of Hermann and the accepted experimental relations.

The integral method of solution may be extended to apply to low Prandtl number fluids, laminar or turbulent flow, variable wall temperature, and convection within confined spaces.

Aerodynamic Interference of Cascade Blades in Synchronized Oscillation, by Chieh-Chien Chang, University of Minnesota, Minneapolis, Minn., and Wen-Hwa Chu, Institute for Fluid Dynamics and Applied Mathematics, University of Maryland, College Park, Md. 1955 ASME Applied Mechanics Conference paper No. **55—APM-16** (in type; to be published in the *Journal of Applied Mechanics*).

THE failure of a compressor is sometimes due to flutter of the blades. Essentially, this problem is equivalent to a cascade in oscillation.

The present analysis is to find the aerodynamic load on cascade in synchronized harmonic oscillations, pitching, and flapping. Conformal mapping is used.

Two characteristic parameters are involved in the force and moment. One is μ which is related to the gap-chord ratio. The other is k which is known as reduced frequency.

The main results are expressed in terms of these two parameters. Most can be

reduced to closed form. The rest are given in graphs. The wake interference involves one new function $C(\mu,k)$ which is related to a ratio of two hypergeometric functions and which reduces to Theodorsen's function $C(k)$ in the limit of infinite gap.

In a certain range of frequency and gap-chord ratio, the analysis shows quantitatively that single-oscillation airfoil theory may lead to inaccurate estimation of interference effect between blades.

On the Kinematic Path of Semitrailers by G. A. G. Fazekas, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1955 ASME Applied Mechanics Conference paper No. **55—APM-11** (in type; to be published in the *Journal of Applied Mechanics*).

A TRAILER having a rigid axle does not quite follow the path of its tractor. The author describes the basic geometry and kinematics involved.

The subject matter is arranged under headings (*a*) transient trailer path in turn, (*b*) design criterion, and (*c*) transient trailer path when straightening out.

A Criterion for Minimum Scatter in Fatigue Testing, by F. A. McClintock, Assoc. Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1955 ASME Applied Mechanics Conference paper No. **55—APM-26** (in type; to be published in the *Journal of Applied Mechanics*).

WHEN a number of fatigue tests are run on specimens with a longitudinal radius of curvature, there results a scatter in both the number of cycles to failure and the position of failure. A previous statistical analysis showed that if the variations in life are due solely to local inhomogeneities in the specimen, then there is a definite relation between the scatter in position of failure and the scatter in the number of cycles to failure. If the scatter in life significantly exceeds that corresponding to the scatter in position of failure, then there is some factor other than local inhomogeneities contributing to the scatter in life. Such other factors can be eliminated by improving the experimental technique.

The usefulness of this criterion is illustrated by its application to crack-detection tests on polycrystalline ingot iron.

ASME Transactions for June, 1955

THE June, 1955, issue of the Transactions of the ASME, which is the *Journal of Applied Mechanics* (available at $1 per copy to ASME members; $1.50 to nonmembers) contains the following:

Technical Papers

Momentum and Mass Transfer in a Submerged Water Jet, by Walton Forstall and E. W. Gaylord. (54—A-38)

Prediction of Creep-Deflection and Stress Distribution in Beams From Creep in Tension, by W. N. Findley and J. J. Poczatek. (54—A-5)

Fracture of Inoculated Iron Under Biaxial Stresses, by I. Cornet and R. C. Grassi. (54—A-47)

The Formation of a Conical Crater in a Thin Plastic Sheet, by W. T. Thomson. (54—A-36)

Thermal Shock on a Circular Surface of Exposure of an Elastic Half Space, by M. A. Sadowsky. (54—A-44)

On the General Three-Dimensional Photoelastic Problem, by Max M. Frocht and Roscoe Guernsey, Jr. (54—A-11)

Determination of Thermal Stresses in Three-Ply Laminates, by A. J. Durelli and C. H. Tsao. (54—A-27)

Stress-Concentration Factors in Shafts With Transverse Holes as Found by the Electroplating Method, by H. Okubo and S. Satō. (54—A-88)

Laminar-Diffusion Boundary Layer—A Review, by Kurt Berman. (54—A-29)

Application of Saint Venant's Principle in Dynamical Problems, by B. A. Boley. (54—A-30)

Frictional Vibrations, by David Sinclair. (54—A-46)

A Kinematic Notation for Lower-Pair Mechanisms Based on Matrices, by J. Denavit and R. S. Hartenberg. (54—A-34)

Acceleration in Mechanisms, by R. T. Hinkle, C. Ip, and J. S. Frame. (54—A-33)

Effect of a Surrounding Fluid on Pressure Waves in a Fluid-Filled Elastic Tube, by M. C. Junger. (54—A-93)

Load Distribution at the Intersection of Several Coaxial Axisymmetric Shells, by H. Becker. (54—A-43)

Solving Highly Complex Elastic Structures in Easy Stages, by Gabriel Kron. (54—A-25)

On a Nonlinear Differential Equation for Beam Deflection, by E. J. Scott and D. R. Carver. (54—A-35)

Problems of Plane Elasticity for Reinforced Boundaries, by J. R. M. Radok. (54—A-92)

Stress Distribution in a Uniformly Rotating Equilateral Triangular Shaft, by H. T. Johnson. (54—A-91)

Further Problems in Orthotropic Plane Stress, by H. D. Conway. (54—A-48)

Stresses Due to Diametral Forces on a Circular Disk With an Eccentric Hole, by A. M. Sen Gupta. (54—A-37)

Bending of Orthogonally Stiffened Plates, by W. H. Hoppmann, 2nd. (54—A-31)

Buckling of Continuous Columns, by H. C. Perkins. (54—A-32)

Brief Notes

Representation of Three-Dimensional Stress Distributions by Mohr Circles, by G. A. Zizicas.

Analysis of Some Circular Plates on Elastic Foundations and the Flexural Vibration of Some Circular Plates, by H. D. Conway.

Discussion

On previously published papers by R. Plunkett, H. H. Uhlig, T. K. Caughey, and J. M. Gere.

Book Reviews

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Comments on Papers

Including Letters From Readers on Miscellaneous Subjects

Power-Plant Design

Comment by Martin Frisch[1]

THE AUTHOR is to be complimented, not only on the excellence of his description of an outstanding power station,[2] but also for the generosity and frankness of his disclosures of the advanced design concepts of the Oak Creek Station, and his important conclusions based on operating experience which are certain to influence future high pressure-high temperature power-station design trends.

The purpose of this brief discussion is to focus the attention of power engineers who have set their sights on even higher pressures and temperatures than now used, on three steam-generator design features disclosed by the author whose long-range advantages will surely not be ignored. These are:

1 Superheating is accomplished al most entirely by radiant heat-absorbing superheating surface.

2 Resuperheating is effected entirely in radiant heat-absorbing reheating surface.

3 Maximum furnace heat-release rate per square foot of all furnace radiant heat-absorbing surface is lower than for any other high pressure-high temperature unit of equal size. The great advantages of this third, and most important, feature were attainable only because of the advanced thinking which led to the incorporation of the first two features into the design concept in recognition of the principle that only by utilizing radiant heat-absorbing surfaces for superheating and reheating to the greatest possible extent could entire freedom and independence from fuel limitations be realized.

There has been some reluctance on the part of steam-generator designers and users to avail themselves of the advantages of radiant superheaters and reheaters demonstrated in many such installations operated by the author and his associates. The latest Oak Creek unit is the thirtieth installed or ordered by the author's company, using radiant superheaters, of which nine also provide for complete radiant reheating. The record of performance and reliability of these installations has been so good as to invite serious study.

The decision to separate the flames from vertical burners firing downward by the use of three water-cooled platens, heated on both sides, in order to reduce unit furnace heat-absorption rates to unusually low and safe values demonstrated another application of sound principles. Although multiple-furnace units had been built before, the Oak Creek units were the first to incorporate this unique arrangement, first proposed by the author in his U. S. Patent No. 2,244,144, and which now has been proved to be so effective for the control of final reheat temperatures.

The superheater, reheater, and furnace-design features described in the paper will certainly be copied as the severity of high-pressure high-temperature steam-generation requirements increases, and they should be copied because the principles underlying the concepts are so sound.

Comment by G. L. Harman, Jr.[3]

The author discusses the differential firing method for control of reheat steam temperature. Because the problems of design and operation were rather unique from the control angle, it might be in order to amplify the design of these controls.

Three main problems were discussed in the design status as follows:

1 Master control of reheat steam temperature.

2 Control to keep reheat temperature at the two boiler outlets identical.

3 Control of fuel-air ratio between cells when differential firing changes were made.

Problem (1) concerned utilization of a steam-temperature controller to modify the control pressure coming from the combustion control system as applied to the individual feeder controls on the separate cells. By using appropriate air relays of standard design, this modifying pressure could either reverse or load directly the feeder controls on the superheat sections versus the reheat sections. Equal increments of control were applied to the feeders under this system so that although the differential firing rate changed between cells, the total amount of firing remained the same, thus not upsetting the primary control system from steam pressure.

Problem (2) was met by incorporating a second temperature-recording pen in the same reheat temperature controller and pneumatically measuring the difference, if any, between the two reheat outlet temperatures. If any difference between these two existed, a pneumatic loading pressure automatically would bias the two reheat sections between themselves without disturbing the superheat section.

Problem (3) was more difficult as it involved proper air and coal measurements to each cell. Air-flow measurements were taken from airfoil-type primary elements and each secondary air-flow transmitter then transmitted its air-flow measurement to respective calibrating pneumatic relays.

The measurement of coal feed would of course be difficult and it was decided to utilize feeder speed or feeder rheostat position as an index of coal feed to the individual cell. The control pressure to each feeder drive would then be an index of coal feed and this control pressure was balanced against the air-flow transmitter pressures in order to have a fuel-air-ratio guide for the individual cells.

The combustion control system, incorporating a steam flow-air flow controller, was superimposed upon the individual air-flow measurements to readjust them all in the same amount from this combustion ratio.

Although not incorporated in the control system, but to serve as a guide for any manual readjustment necessary, an oxygen recorder was utilized with gas-sampling tubes located to pick up any differences between cells in so far as excess air is concerned.

Comment by Henry H. Hemenway[4]

It is interesting to note the advantages

[1] Vice-President, Foster Wheeler Corporation, New York, N. Y. Fellow ASME.

[2] "Oak Creek Power Plant," by M. K. Drewry, MECHANICAL ENGINEERING, vol. 77, January, 1955, pp. 12–18.

[3] District Manager, Bailey Meter Company, Milwaukee, Wis. Mem. ASME.

[4] Chief Engineer, Steam Department, Foster Wheeler Corporation, New York, N. Y. Mem. ASME.

outlined of the controlled-circulation boiler. The use of small tubes does have certain advantages over the larger 3-in. tubes normally used in natural-circulation boilers. A possible disadvantage is the reduced storage capacity of the small tubes. It would be well to point out, however, that the use of small tubes need not be restricted solely to units with mechanical pumps. The gravity pump used on all natural-circulation boilers has more than sufficient capacity to pump water through smaller tubes such as 2-in. OD and $1^1/_2$-in. OD at pressures as high as 2500–2700 psi.

Comment by Charles D. Wilson[5]

The close-coupled cross-compound steam turbine-generator unit, used in the Oak Creek Station, is ideally suited to take full advantage of the high levels of performance that are possible with the availability of cool Lake Michigan water. This type of turbine arrangement also has practically unlimited possibilities for future development into units of larger capability.

The author and the Wisconsin Electic Power Company are to be commended for the many new and advanced features in power-plant design which are described in the paper and are now in operation at the Oak Creek Power Plant.

Comment by R. A. Wilson[6]

The writer is associated with the company which furnished the condenser and auxiliaries at Oak Creek. Hence we have followed these phases of the plant with interest since its early design stages.

It is believed that the circulating water-tunnel arrangement is unusual and very efficient. The use of a standpipe to relieve excessive head on mixed-flow or axial pumps is entirely new or certainly very rare. This application has been successful and worth while in this plant.

The water conditions are favorable for producing a good year-around vacuum. The author and his associates have capitalized on this situation to the fullest extent both at Oak Creek and at Port Washington.

An initial difficulty of the condenser becoming clogged with industrial waste is interesting in view of the fact that this plant is located only a few miles from other plants which have been quite free of this problem. It seems that this problem may not be so serious after the first several months of operation. The backwashing arrangement which the author designed and installed has been a great success.

[5] Engineer-in-Charge, Steam Turbine Design, Allis-Chalmers Manufacturing Company, Wilwaukee, Wis. Mem. ASME.

[6] Blower and Condenser Section, Power Department, Allis-Chalmers Manufacturing Company, Milwaukee, Wis. Assoc. Mem. ASME.

Author's Closure

Discussers are thanked gratefully for their participation.

M. K. Drewry.[7]

Maintenance of Rolling Stock

Comment by W. M. Keller[8]

In a scholarly manner this paper points up[9] a theoretical method of evaluating procedures required in the maintenance of equipment. It should be the basis for further study on the vital problem of evaluating expense involved in providing maintenance with the consequences of its reduction.

Rolling stock poses a critical maintenance problem since equipment failures affect not only the cost of restoring the part to its original condition, but also the relation of the failed part to damage hazard to other equipment, schedule delays, shipper and passenger dissatisfaction, and a large group of other factors.

The advantages of the method of predicting incidence of failure in relationship to maintenance, as proposed in the paper, are evident from a consideration of the alternative method available to establish these facts. At present most knowledge of this type is empirical, as it is obtained from actual experience. To determine the extent to which maintenance can be reduced without seriously increasing failures it is necessary actually to reduce the maintenance and keep a subsequent record of failures.

The authors present a number of generalized curves. To utilize the full advantage of the system detailed curves would be necessary. These curves would have to be developed from actual data and perhaps for certain details, calculated life-expectancy curves would be necessary. With such curves we could predict the maintenance "premium" necessary for acceptable performance. While the figures thus obtained would not be absolute values they nevertheless would serve as an accurate guide.

The railroad adoption of the authors' theory presents difficulties in its practical application, particularly from the standpoint of economics, that are almost insurmountable. The amount of time and money that necessarily must be expended to acquire what might be termed actuarial tables for all the parts involved in railroad operation are not at this time available to the railroad industry. Such a system would likely be adopted in steps or in small areas of operation. If its development in this way produces outstanding evidence of saving the idea would quickly spread. When the savings resulting from its use became definitely evident in problems of simple scope the adoption would likely become more widespread.

[7] Chief Engineer of Power Plants, Wisconsin Electric Power Company, Milwaukee, Wis. Mem. ASME.

[8] Director of Mechanical Research, Association of American Railroads, Central Research Laboratory, Chicago, Ill. Mem. ASME.

[9] "Theory of Maintenance of Rolling Stock," by R. R. Crane and F. B. Brown, Mechanical Engineering, vol. 76, December, 1954, pp. 999–100, 1009.

Comment by D. C. Turnbull, Jr.[10]

The purpose of the paper is to indicate some applications of failure theory to replacement and maintenance of rolling stock. The techniques as explained by the authors purport to show at what point periodic inspection and maintenance costs overbalance the cost of in-service failures; i.e., what is the most economical level.

Practically all railroads have built up records of maintenance expense and potential useful life of rolling stock over long periods. They have developed rules for replacement or renewal of parts, due to wear, age, and defects, or, in extreme cases, failure of parts. Their inspection procedures are based on knowledge which has been gained from their records, from personal experience, and on recommendations from manufacturers of equipment.

Failure of equipment in service can cause accidents involving serious delays and can be costly. Just one major failure may completely wipe out any savings realized through decreased maintenance and inspections. Therefore railroads make every reasonable attempt to avoid accidents and delays through close inspections and proper maintenance.

Since proper inspections and maintenance lower the accident rate and minimize their effect, as well as tend to lengthen the useful life of equipment, it is doubtful whether a system involving less inspection and less maintenance at the expense of hazards would be acceptable to railroads.

Authors' Closure

The comments of Mr. Keller and Mr. Turnbull on the article, "Theory of Maintenance of Rolling Stock," are

[10] Executive Assistant to President, Baltimore and Ohio Railroad Company, Baltimore, Md. Mem. ASME.

considered to be illuminating and constructive. In general we concur with the content of these comments.

We wish to stress the point, however, that the purpose of the article was to present a method which could be useful to the railroads upon application to this practical problem. Thus the question raised by the discussers on obtaining data for the actual application of this method on a railroad is, therefore, considered to be the crucial one. In our opinion, it is practicable to obtain the data necessary to satisfactorily apply the method to this problem, and in fact, in one instance this has already been done by a railroad.

Roger R. Crane.[11]
Frank B. Brown.[11]

[11] Westinghouse Air Brake Co., Pittsburgh, Pa.

Reviews of Books

And Notes on Books Received in Engineering Societies Library

Science and Invention

AMERICAN SCIENCE AND INVENTION: A Pictorial History. By Mitchell Wilson. Simon and Schuster, New York, N. Y., 1954. Cloth, 9 × 12 in., illus., bibliography, index, ix and 437 pp., $10.

Reviewed by J. K. Finch[1]

THIS is not only a picture book, but it is also a big book. The page size is nine by twelve inches, there are over four-hundred pages and there are twelve-hundred reproductions of drawings, engravings, photographs, and paintings. It is the result of a tremendous labor of collection and compilation and a triumph of publication. But it is also a curious book; a confusing patchwork of pictures and text, frequently dealing with completely unrelated subjects—the Wright Brothers sandwiched in between Millikan, the electron expert, and Hale, the solar explorer, Westinghouse holding uneasy company between the typewriter and photography—an almost unbelievable hodge-podge of pictures and text.

The author states in his preface: "The 'civilized man' may be defined as someone who is at home in his own time and place; it is my belief that to be a civilized American today we must be as aware of the mainspring of contemporary America —its technology—as Americans of a hundred years ago were aware of the soil."

While there are those, such as the Hottentot, who may be regarded as "at home" in their own time and place and yet fail to be civilized, we would agree with the author that engineering progress has, in the last two centuries, created a new culture—transformed the economic and social conditions of life and changed the relationships of men—and that it is desirable that American citizens be at home with this evolutionary force which has them in its grasp. Yet we cannot agree that this publication will add much more than confusion to the picture.

Perhaps the answer is to be found in the fact that the author seems to know little of the history of engineering or industry. In fact, he denies that he is an historian and calls himself "novelist and scientist." He appears to think, for example, that engineering emerged in the United States about a century ago and primarily as a by-product of natural science. We are told, for example, that "The graduates of the Erie Canal went into the world and the word *engineer* came into common use." Also that "The engineering colleges of America did not begin until after the Civil War." We hope that the first of these "boners" does not cause the great early French engineers, or their British colleagues to turn over restlessly in their graves. We assure the West Point Military Academy, founded as an engineering school in 1802; Norwich in Vermont, which was teaching engineering in 1819; and Rensselaer which began shortly thereafter, that we know better.

The author also holds that: "Advances in science sprang from man's impulse to increase his power over the world by understanding it. Advances in invention came when he used this new knowledge to create better tools." Actually, the history of science and engineering show quite the reverse. The arch and the truss were developed to meet man's needs and wants centuries before we had more than a purely qualitative knowledge based on experience of the mechanics of their action. Watt's steam engine came before the modern theory of heat—in fact prompted the search for better understanding just as the modern theory of aerodynamics followed the work of the Wright Brothers.

Invention has been described as the marriage of an idea with the means of its realization. The most notable contribution of greater understandings in natural science has been in making possible the improvement of the many essentials of modern life—a better product at less cost. To be sure, new discoveries in science have opened up new vistas for ideas, but it will be a sad day for American leadership when we come to rely—as the propaganda of modern science advises us to—on science alone as the one and only ingredient of engineering and industrial progress. The author seems to have neglected or ignored our greatest asset, engineering and industrial "know-how."

While, as we have said, the individual stories in the text are written with journalistic enthusiasm and color there are, as might be expected, a number of

[1] Dean Emeritus and Renwick Professor Emeritus of Civil Engineering, Columbia University, New York, N. Y.

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statements that can be questioned. We are told—to note only one—that "During World War II, techniques of instrumentation perfected E. E. Armstrong's system of frequency modulation." The regenerative circuit which Edwin H. Armstrong devised in 1913, his "super-het" of World War I, his Alpine demonstration of "FM" in 1938 are not mentioned—instrumentation, not Armstrong, apparently made FM possible.

Perhaps the best summary of this work is that given in the subtitle: "The fabulous story of how American dreamers, wizards, and inspired tinkerers converted a wilderness into the wonder of the world." There you have it in a nutshell. What a futile, distorted, misleading, pseudohistorical picture this creates of the men and forces which have made modern America the leading engineering and industrial nation of the world.

Books Received in Library ...

ANALYSIS OF DEFORMATION. Volume 2: Experimental and Applied Theory. By Keith Swainger. The Macmillan Company, New York, N. Y., 1955. 365 p., $8^3/_4 \times 5^1/_2$ in., bound. $13.50. The theory formulated in volume 1 is here applied to various stress conditions of rather generalized nature such as homogeneous or heterogeneous two-stress situations, rubber deformation, and couples applied to massive bodies. Experimental evidence has been examined and incorporated in the treatment. Subsequent volumes are to deal with buckling, thin plates, vibrations, and similar topics.

ANNUAL REPORT ON THE PROGRESS OF RUBBER TECHNOLOGY. Volume 18, 1954. Edited by T. J. Drakeley. Published by W. Heffer & Sons, Ltd., Cambridge, England, for the Institution of the Rubber Industry, London. 186 p., $9^3/_4 \times 7^1/_4$ in., bound. £1, 1s. A critical review of the literature, including patents, covering the most significant advances in the field. A general statistical and historical survey precedes the more specialized reports on developments in synthetic rubber, testing and equipment, machinery and appliances, cable and electrical insulation, etc.

AUXILIARY PAPER MILL EQUIPMENT. (Pulp and Paper Manufacture, volume 4.) J. Newell Stephenson, editor in chief. McGraw-Hill Book Company, Inc., New York, N. Y., 1955. 732 p., $9^1/_4 \times 6$ in., bound. $9. This concluding volume of the series covers instrumentation and process control; pumps and agitating equipment; materials handling; heating and ventilating; steam generation and distribution; water; electrical equipment; and bearings and lubrication. Principles, methods, and applications of the topics discussed are presented in terms of practical use in pulp and paper mills.

BIBLIOGRAPHY ON INDUSTRIAL RADIOLOGY, 1952–1954. (Fifth Supplement to "Industrial Radiology.") By Herbert R. Isenburger. St. John X-Ray Laboratory, Califon, N. J., 1955. 24 p., $11^1/_2 \times 9$ in., paper. $3. A chronological listing of nearly 700 references to periodical articles, documents, books, and patents. Foreign articles are included with titles given in English.

BOMB, SURVIVAL, AND YOU. By Fred N. Severud and Anthony F. Merrill. Reinhold Publishing Corporation, New York, N. Y., 1954. 264 p., $9^1/_4 \times 6$ in., bound. $5.95. The authors—a structural engineer and a journalist with firsthand experience with urban bombings in England—have attempted to bring together all pertinent information in a form that will be of interest to engineers, architects, civil-defense workers, and laymen. They discuss characteristic effects of atom bombs; data from Hiroshima and Nagasaki; fire control; shelter construction; protection of machinery; strengthening existing structures; and design of bomb-resistant buildings. The design information included is of a general nature and will be supplemented by a second volume containing mathematical analyses of blast loadings.

CALCUL THERMIQUE DES CHAUDIÉRES ET DES FOYERS. By Friedrich Nuber. Translated from the twelfth German edition by Léon Thiry. Dunod, Paris, France, 1954. 302 p., $8^1/_2 \times 5^1/_2$ in., bound. 1850 F fr. A detailed treatment of combustion and heat-transmission calculations, essentially concerned with boiler and furnace operation. The coverage is wide from generalized treatments on through calculations for individual pieces of equipment to the over-all design of boiler-room installations.

DEPRECIATION. By Eugene L. Grant and Paul T. Norton, Jr. Ronald Press Company, New York, N. Y., revised printing, 1955. 504 p., $9^1/_4 \times 6^1/_4$ in., bound. $7.50. This comprehensive manual for engineers, accountants, and industrial managers deals with depreciation from the point of view of accounting and income taxes, and with the uses and limitations of depreciation-account figures as a guide to decisions on business problems. The revised printing includes a new chapter on the Internal Revenue Act of 1954 as it affects the rules governing depreciation-tax practice.

ELEMENTS OF SERVOMECHANISM THEORY. By George J. Thaler. McGraw-Hill Book Company, Inc., New York, N. Y., 1955. 282 p., $9^1/_4 \times 6^1/_4$ in., bound. $7.50. This text for senior students presents basic theory without using operational calculus or complex-variable theory, emphasizes frequency-response methods, and integrates and compares the polar and logarithmic approaches to analysis and design. The chief topics treated are transient analysis; transfer functions and transfer-function plots; analysis of single-loop systems; gain adjustment; series compensation; and feedback compensation. The two final chapters of the book introduce such advanced topics as root-locus methods and phase-plane techniques.

ENGINEERING METALLURGY. By E. M. H. Lips. Philip's Technical Library, Eindhoven (available in U. S. from Elsevier Press Inc., 402 Lovett Boulevard, Houston, Texas), 1954. 250 p., 9×6 in., bound. $6.25. The aim of this book is to help the engineer in his choice of the most appropriate materials for engineering components and machines. With emphasis on practical applications of the topics treated, the seven sections of the book deal with mechanical properties of metals and alloys; phase diagrams; alloys of iron; nonferrous metals and alloys; corrosion; heat-treatment; and working and joining. Values are expressed in inches, pounds, tons, Fahrenheit, etc., as well as in metric units.

ENGINEERING ECONOMICS AND PRACTICE. By Max J. Steinberg and William Glendinning. Available from W. Glendinning, Bayside, N. Y., fourth edition, 1955. 114 p., $11 \times 8^1/_2$ in., paper. $3. This is a summary of accepted theory and practice designed as an aid to engineers preparing for professional examinations and as a convenient reference manual for practicing engineers. Topics dealt with include compound-interest formulas; depreciation; comparison of alternate proposals; calculating a prospective rate of return; replacements; and costs. Text material is supplemented by questions and solutions to problems which were taken from Part 3 of the New York State examinations.

ÉTUDE DE LA DÉFORMATION ET DE LA RUPTURE DES MATIÈRES PLASTIQUES. By Félix Zandman. France, Ministère de l'Air, Publications Scientifiques et Techniques, No. 291, Paris, France, 1954. 198 p., $10\ ^5/_8 \times 7^1/_8$ in., paper. 2300 fr. An analytical study of the plastic state and of the deformation and fracture of solids. Photoelastic methods including the use of high-speed photography are dealt with in addition to the numerical and graphical approaches.

FLEXURE DEVICES. By P. J. Geary. British Scientific Instrument Research Association, Kent, England (Research Report M.18), 1954. 44 p., $9^1/_2 \times 6$ in., paper. 10s, 6d. The first of a series of bibliographical surveys of instrument parts. The booklet contains digests of 28 articles and patents of major importance, and a list of 111 articles of secondary importance published in English and foreign periodicals from 1900 to 1954. The references, listed by date of publication, cover flexure pivots, parallel movements, twin-strip mechanisms, buckling-strip devices, and the sine spring. A technical introduction discusses advantages and limitations of the devices. An author index and a subject index to the secondary references are provided.

FLIGHT HANDBOOK. Compiled by the staff of *Flight*. Edited by Maurice A. Smith. Philosophical Library, New York, N. Y., fifth edition, 1954. 282 p., $8^1/_2 \times 5^1/_2$ in., bound. $6. The purpose of this handbook is to present a concise review of the basic information necessary for understanding the more specialized technical literature on airplanes, airplane engines, and associated aviation subjects. Separate chapters are devoted to principles of aerodynamics; aircraft structures; landing gear; controls; gas turbines; instruments; and other topics. Although the emphasis is on British practice, frequent reference is made to American experience.

FLUID MECHANICS. By R. C. Binder. Prentice-Hall, Inc., New York, N. Y., third edition, 1955. 388 p., $9^1/_4 \times 6^1/_8$ in., bound. $7.65. An introductory textbook which aims to present a balanced practical treatment of fundamentals and to keep physical concepts and quantitative relations in the foreground. Part 1 covers basic relations: fluid statics; geometry of motion; the relation between force, mass, and acceleration; internal friction; etc. Part 2 gives information on current practices and on applications of the basic material of Part 1. Each chapter is followed by a list of selected references and numerous problems.

HANDBOOK OF APPLIED MATHEMATICS. Edited by Edward E. Grazda and Morris Brenner, based on the original work by Martin E. Jansson, Herbert D. Harper, and Peter L.

Agnew. D. Van Nostrand Co., Inc., New York, N. Y., third edition, 1955. 1044 p., 8 × 5¼ in., bound. $7.50. The first six chapters review the fundamentals of arithmetic, algebra, geometry, trigonometry, and differential calculus; succeeding chapters deal with applications to practical problems in the building trades, machine-shop work, electricity, electronics, printing, business, and accounting. The book is intended both as a reference manual as well as a text for self-instruction.

HANDBOOK OF TEXTILE FIBERS. Edited by Milton Harris. Harris Research Laboratories, Inc., Washington, D. C., 1954. 356 p., 11¼ × 8½ in., bound. $12.50. Information and tables of data on both natural and man-made fibers provide extensive coverage of physical and chemical properties of a wide range of fibers, fiber types and sources, constitution and structure of fibers, effect of biological agents, fiber identification, and yarn numbering and count systems. Also given are economic and production data, a glossary, a list of textile periodicals, and tables of chemical and engineering data.

HIGHER TRANSCENDENTAL FUNCTIONS. Volume 3. Compiled by the staff of the Bateman Manuscript Project at the California Institute of Technology. McGraw-Hill Book Company, Inc., New York, N. Y., 1955. 292 p., 9¼ × 6¼ in., bound. $6.50. This third and final volume contains chapters on automorphic functions, Lamé and Mathieu functions, spheroidal and ellipsoidal-wave functions, functions occurring in number theory, and generating functions. Treatment varies from a detailed account of some functions to brief descriptive accounts of the properties of others, with many references to the literature in the field.

HYDRAULIC OPERATION AND CONTROL OF MACHINES. By Ian McNeil. Thames and Hudson, London, England, 1954 334 p., 8¾ × 5½ in., bound. 35s. This comprehensive up-to-date treatment of hydraulics as a means of transmitting power and controlling mechanical motion stresses the practical side of the subject. With frequent reference to actual machines and devices, the author discusses pumps and motors; valves and circuits; accumulators, intensifiers, and power-saving devices; fluids; seals, packings, pipes, and couplings; and hydrokinetic power transmission. Also dealt with are forging presses; extrusion machines; deep-drawing and stamping presses; machine tools; molding and die-casting machines; and uses of hydraulic power in mining, agriculture, aeronautics, and marine engineering.

IP ENGINE TEST METHODS FOR RATING FUELS. Institute of Petroleum, London, England, 1955. 84 p., 8½ × 5½ in., paper. £1. The methods contained in this booklet are for determining the knock rating of motor and aviation fuels and the ignition quality of diesel fuels. Information given for each method includes applicability, apparatus, materials, procedure, calculation, and reporting. Where possible both British and metric units of measurement of volume, dimension, and temperature are used.

KLEINES HANDBUCH TECHNISCHER REGELVORGÄNGE. By Winfried Oppelt. Verlag Chemie, Weinheim, Germany, 1954. 447 p., 9½ × 6¾ in., bound. 31.80 DM. This manual on industrial-control systems describes the design and construction of the more important control devices and presents the mathematical fundamentals for the solution of control problems. Charts and diagrams are profusely used to illustrate the characteristics of the various devices and systems covered. There is a classified bibliography of six-hundred references including many in English.

LINEARIZED THEORY OF STEADY HIGH-SPEED FLOW. By G. N. Ward. Cambridge University Press, New York, N. Y., 1955. 243 p., 8¾ × 5½ in., bound. $6. The first part of this monograph gives the derivation and interpretation of the linear equations for steady motion, the solution of these equations, a discussion of the boundary conditions and aerodynamic forces, and the deduction of results of a general character. The second part deals with special problems mainly of supersonic flow, and the third part contains an account of slender-body theory. A knowledge of the theory and practice of compressible fluid flow and of vectorial notation, used extensively by the author, is required from the reader.

METAL CLEANING BIBLIOGRAPHICAL ABSTRACTS, 1954 SUPPLEMENT. (Special Technical Publication, No. 90-C.) By Jay C. Harris. American Society for Testing Materials, Philadelphia, Pa., 1954. 40 p., 9 × 6 in., paper. $1.50. Containing 227 new references, 1952–1954, this publication brings up to date the 1953 edition (Special Publication 90-B), which was a combined bibliography of references from 1842–1951. Arrangement is by year and secondarily by author or periodical with author, subject, specification, and patent indexes.

MODERN PETROLEUM TECHNOLOGY. Institute of Petroleum, London, England, second edition, 1954. 702 p., 9¼ × 6 in., bound. 35s. In this outline of the scientific and technical background of the petroleum industry, various specialists review the present state of knowledge of specific topics under the following broad headings: exploration and production; manufacture and refining; properties and utilization of products; testing; transport and distribution; and economic aspects. Many of the articles in this edition have been rewritten and some are completely new.

NOISE-REDUCTION MANUAL. By P. H. Geiger. University of Michigan, Engineering Research Institute, Ann Arbor, Mich., 1955. 167 p., 9¼ × 6 in., bound. $4. This is a practical manual dealing with the principles involved in noise problems and with various approaches to their solution. In the opening chapter, procedures for reducing sound waves generated by machinery are discussed in general terms. Later chapters consider in more detail specific applications of sound absorption and insulation, vibration damping, and vibration isolation. Units, instruments, and techniques for measuring noise are also treated in this manual.

NUMERICAL METHODS. By Andrew D. Booth. Academic Press, Inc., New York, N. Y., 1955. 195 p., 8¾ × 5½ in., bound. $6. A discussion of the mathematical principles underlying the art of programming for an automatic digital calculator. The volume covers interpolation; numerical differentiation and integration; summation of series; ordinary differential equations; simultaneous linear equations; partial differential equations; nonlinear algebraic equations; approximating functions; Fourier synthesis and analysis; and integral equations.

PHYSIQUE DES VIBRATIONS Á L'USAGE DES INGÉNIEURS. By A. Fouillé. Dunod, Paris, France, 1954. 546 p., 9⅜ × 6⅛ in., paper. 4800 F fr. An extensive textbook for engineers on the physics of vibratory motion. It is arranged in four main sections: Basic wave mechanics of solids and liquids; acoustics, including ultrasonics; optics, including polarization and spectroscopy; and a miscellaneous group of radiation phenomena. Some forty pages of representative practical problems are appended.

PROBLEME DES ZYKLONABSCHEIDERS. (VDI–Tagungsheft 3.) Verein Deutscher Ingenieure. Deutscher Ingenieur-Verlag, Düsseldorf, Germany, 1954. 44 p., 11¾ × 8¼ in., paper. 15 DM. Papers and discussions contributed to a VDI-sponsored symposium on cyclone separators. The several papers deal with design considerations and calculations or describe the results of various full-scale experiments.

PROFESSIONAL LOOK AT THE ENGINEER IN INDUSTRY. National Society of Professional Engineers, Washington, D. C., 1955. 124 p., 9 × 6 in., paper. $3. (Members $1.50.) The purpose of this study is to examine the methods by which the interests of engineers working as employees can be defined, recognized, and treated. The legal background—the Wagner and Taft-Hartley acts—is discussed in relation to engineering organization, the causes of dissatisfaction are analyzed, and the issue of professionalism versus unionism is examined. Recommendations for a program of action include the improvement of professional status, improvement in employment conditions, and improvement in economic position.

PROTECTIVE COATINGS FOR METALS. By R. M. Burns and W. W. Bradley. Reinhold Publishing Corporation, New York, N. Y., second edition, 1955. 643 p., 9¼ × 6 in., bound. $12. The composition, properties, and performance of both metallic and organic coatings are treated in relation to the solution of protection problems, with only brief consideration given to the production of coatings. The eighteen chapters provide comprehensive coverage of the entire field of coating technology, including surface preparation, sprayed metal coatings, methods of test, corrosion and inhibitors, and a wide range of materials and applications. This edition has been largely rewritten. An author index to the extensive bibliographical footnotes is provided.

SERVOMECHANISMS AND REGULATING SYSTEM DESIGN. Volume 2. By Harold Chestnut and Robert W. Mayer. John Wiley & Sons, Inc., New York, N. Y., 1955. 384 p., 9¼ × 6 in., bound. $8.50. The first volume, published in 1951, dealt with basic mathematics, physical problems, and design solutions in a manner suited to the needs of students and engineers without previous training in closed-loop control. The present volume, a more advanced treatment intended for practical designers and graduate students, covers measurement techniques; specifications; methods of selecting power and stabilizing elements; amplifier design; all a-c servomechanism design; and nonlinearities in control-system design. Illustrative problems adapted from actual design projects are included.

TABLES NUMÉRIQUES DE PHYSIQUE NUCLÉAIRE. (Numerical Tables of Nuclear Physics.) By Charles Noël Martin. Gauthier-Villars, Paris, France, 1954. 258 p., 9½ × 6 in., paper. 1800 F fr. An extensive presentation of numerical data relating to the major energy phenomena occurring in atomic nuclei. The fourteen tables are in two groups: Six tables based on the semiempirical formula for calculating the masses of the atoms; and eight tables of values for calculating various nuclear reactions. Each table is preceded by an explanatory section.

ASME NEWS

With Notes on the Engineering Profession

ASME To Participate in Huge Nuclear Parley—Authorities to Reveal Latest "Atoms-for-Peace" Progress

Equipment and Materials to Be Unveiled at Concurrent Atomic Exposition, Dec. 12–16

UNITED STATES and foreign engineers, scientists, and industrial representatives from 24 business and technical societies, including The American Society of Mechanical Engineers, 16 universities, 13 government bureaus and AEC contractors, and 34 major U. S. industrial corporations will present nearly 300 papers in 50 sessions in one week covering practically every phase of peacetime uses of atomic energy and its by-products at the Nuclear Engineering and Science Congress in Cleveland, Ohio, December 12 through 16.

Co-ordinating the arrangements for the Congress is the Engineers Joint Council under the leadership of Thorndike Saville, dean of the college of engineering, New York University, and president of EJC.

While the technical sessions are under way at the Cleveland Public Auditorium, leading U. S. and foreign industrial firms who are harnessing the atom for industry, medicine, and agriculture will be displaying their equipment and know-how in the first International Atomic Exposition in the building's five exhibit halls.

The week of December 12 was selected for the events because none of the 24 participating groups has other meetings scheduled for that period. The Congress results from a co-operative effort on a scale never before attempted by the nation's leading engineering societies and trade associations. The 24 participating groups have a total membership of over 400,000.

The Atomic Exposition is sponsored by the American Institute of Chemical Engineers, headed by Prof. Barnett F. Dodge of Yale University. Professor Dodge said information from many of the exhibitors reveals that a great deal of special equipment developed for peacetime uses of the atom will get its first public showing at Cleveland.

Simultaneous Sessions

Representatives of the 24 participating societies have approved plans for 50 technical sessions in Cleveland with as many as five separate sessions being held simultaneously. Typical of the co-operation achieved is the joint participation in these sessions. For example, 39 of the sessions will have papers from two or more societies. In one session, five separate societies are being represented through technical papers.

Preliminary plans for the program include speakers and topics covering Canadian, English, Australian, and South African nuclear developments for peacetime uses as well as the American aspects. England's Harwell project and Atomic Energy of Canada, Ltd., are both represented in the line-up of technical papers.

All-Congress Session

Plans for an All-Congress session will be announced later. A special committee headed by John R. Dunning, Mem. ASME, chairman, EJC General Committee on Nuclear Engineering and Science and dean of engineering at Columbia University, is making arrangements for this important event. Members of the special committee include T. Keith Glennan, president, Case Institute of Technology, Cleveland, and former AEC Commissioner; Joseph H. Gepfert, division manager, Reeves Pulley Company; Walker L. Cisler, Fellow ASME, president, Atomic Industrial Forum, Inc., and Philip Sporn, Fellow ASME, president, American Gas and Electric Company, New York.

Many of the sponsoring or participating organizations will schedule luncheons or dinners for their members during the Congress.

The Cleveland Engineering Society and the Cleveland Technical Societies Council are co-operating in handling local arrangements in Cleveland.

No Geneva Repetition

"Material presented at the Geneva 'Atoms for Peace' conference will not be accepted for presentation at Cleveland," Donald L. Katz, Mem. ASME, chairman of the Congress Program Committee, emphasized in discussing preliminary program plans. Dr. Katz is chairman of the chemical and metallurgical-engineering department at the University of Michigan. The Program Committee has grouped the 292 papers to be presented into 50 general topic headings.

Prominent among these 50 session topics are the "where and how" of atomic power plants with emphasis on safety and selection of site; radiation hazards and their controls; pros and cons of the varied proposed power-plant types; atomic reactors for research purposes and radiation laboratories; radioisotopes and tracer techniques for industry; medicine and agriculture; disposal of radioactive wastes; what to do about radioactive fall-outs; uranium geology—where uranium is and how to discover it.

Reactor Models

Reactor models of the latest design will be shown in the Exposition. Several of these are still undergoing last-minute design changes and will be completed only a short time before the Atomic Show opens on December 10.

To handle the "hot" materials encountered in atomic installations, specially designed handling equipment capable of being remotely operated with great accuracy has been, and is still being, developed. These remote "mechanical hands" and their accompanying controls will be in operation at the show. Closed-circuit television, a vital accessory to many of these installations, will be another feature.

Since many of the conventional materials do not have the properties essential for use in radioactive installations, newly developed alloys and materials possessing unusual properties will get a lot of attention. Some of the materials to be shown were, until recently, just symbols on a periodic table as far as most engineers are concerned. Exposition visitors will discover that there is no such thing as "rare earths or metals" since nuclear science is bringing many of them into daily usage.

The Exposition in Cleveland's Public Auditorium, where many of the technical sessions will be held also, will be open to the general public on December 10 and 11, and in the evenings December 12 through 16. Registrants to the Congress will be admitted to the Exposition at any time. The show will be open to representatives of industry, medicine, and agriculture in the daytime hours December 12 through 16.

Sponsors and Participants

Sponsors and participants in the Congress include:

American Society of Civil Engineers, American Institute of Mining and Metallurgical Engineers; The American Society of Mechanical Engineers; American Water Works Association; American Institute of Electrical Engineers; The Society of Naval Architects and Marine Engineers; American Society for Engineering Education; American Society of Refrigerating Engineers; American Institute of Chemical Engineers. All of these are members of the EJC.

Additional sponsors and participants include:

American Chemical Society; American Institute of Physics; Institute of Radio Engineers; American Nuclear Society; American Geological Institute; American Society for Metals; American Rocket Society; Institute of Aeronautical Sciences; Atomic Industrial Forum, Inc.; Society of Automotive Engineers; and American Society for Testing Materials.

The American Geological Institute is represented by Mineralogical Society of America; Society of Exploration Geophysicists; Society of Economic Geologists and Geological Society of America; American Association of Petroleum Geologists and Society of Economic Paleontologists and Mineralogists.

Commenting on the extent of society cooperation already achieved, Dean Saville said: "It is our conviction in EJC that the universal nature of technological advances makes it imperative that the ground be broken, now looking toward a degree of intersociety co-operation never before thought possible. I sincerely believe that the Nuclear Congress is an important step toward this goal."

ASME High-Temperature Steam-Generation Studies Promise More Economical Power

COUNTER to the trend of the past decade with its steadily rising prices, the cost of electric power to the home consumer has been declining during the period while the cost to commercial and industrial users has at least not risen. For this agreeable situation the thanks of the benefited groups are largely due the research programs, which have made it possible for central-station generating plants to improve their efficiency by the use of increasingly higher steam temperatures and pressures. To achieve further efficiency, however, has now become a much more difficult matter owing to two factors. The first of these factors is the severe corrosive action of high-temperature steam; the second is the lack of metallurgical stability of the materials available for superheater tubing.

Corrosion Problem

The corrosion problem has been under attack for a number of years. Between 1936 and 1942 a special research committee of The American Society of Mechanical Engineers sponsored work on it at Purdue University. This research, which was financed by Engineering Foundation, Purdue University, and industry, was discontinued during the war. It was reestablished in 1949 as a project to study the possibility of using a regenerative steam cycle at temperatures up to 1650 F.

Four factors are being studied at the present time: the properties of the oxide films formed on steel exposed to high-pressure steam at temperatures between 1100 and 1500 F; the resistance of superheater steels to the gases encountered with commercial fuels; the metallurgical stability of the materials during high-temperature service for periods up to three years; and the effect of repeated thermal shock.

Laboratory tests with synthetic atmospheres have been completed, as have field tests in eleven different generating units. According to these tests, several available steels are capable of satisfactory service when delivering steam at temperatures up to 1200 F except when certain types of residual oils and waste fuels are burned.

Philip Sporn Plant Tests

New tests that promise to be widely significant will be made at the Philip Sporn Plant of the American Gas and Electric Company, where steam is available at 2000-psi pressure and 1000 F temperature. For these tests, special apparatus has been designed in co-operation with the U. S. Navy Bureau of Ships. Electric superheaters and counterflow heat exchangers will be installed in the plant to provide the required steam temperatures. This steam will be passed through five test racks of identical design. Racks one and two will contain specimens of selected ferritic steels maintained at 1100 and 1200 F, respectively. In the other three racks there will be specimens of selected austenitic steels, which will be held at 1200, 1350, and 1500 F.

It will be some five or six years before the test program at the Sporn plant can be completed, as exposure of the specimens to high-temperature steam for a minimum of three years is necessary.

The effect on heat transfer of the corrosion products formed by steam on the inside of steel tubes is now being studied in special equipment designed and installed at Purdue University. In this project, steam is passed through a counterflow heat exchanger and electric superheater connected in series, which will deliver steam at 1000 F. The steam is then passed through two identical heat exchangers in series, one of which contains a clean tube and the other a corroded tube of the same steel. By measuring the flow and the temperature rise through the two heat exchangers in series, the effect of the scale on heat transfer can be determined. The thickness of the scale and its metallurgical characteristics will also be determined.

Engineering Foundation Helps Studies

The work of the ASME Committee on High-Temperature Steam Generation shows how a major problem that cuts across the field of many companies and associations can be cooperatively attacked with widely beneficial results under the sponsorship of an organiza-

Shown is the Glenn L. Martin Institute of Technology of the University of Maryland, College Park, Md., which was dedicated on March 25. The Institute consists of eight buildings erected within the past six years at a cost of $8.5 million. The central unit is the College of Engineering with its departments of aeronautical, chemical, civil, electrical, and mechanical engineering; the Institute for Fluid Dynamics and Applied Mathematics; and the Wind Tunnel. It also includes the Institute of Molecular Physics, and the departments of chemistry, mathematics, and physics. The dedicatory address was delivered by Lee A. DuBridge, president, California Institute of Technology. The occasion was marked by the presentation of honorary degrees. Among the recipients was H. L. Dryden, Fellow ASME, who received a DE degree.

tion like Engineering Foundation. Contributions to the program from equipment manufacturers, utilities, trade associations, and Engineering Foundation are expected to reach $200,000. To this must be added the contribution of engineering services provided by the Navy Bureau of Ships for the design and fabrication of the testing equipment, which is estimated at $125,000, plus the time and effort of members of the committee and others who have spent many days in formulating the program.

Inquiries concerning the program may be addressed to Prof. H. L. Solberg, chairman of the committee and head of the School of Mechanical Engineering at Purdue University, Lafayette, Ind.

ABC Conference Advances Mutual Co-Operation

HOPE for continued progress in standardization of screw threads and gaging by the English-speaking countries was voiced by Roger Gay, past-president of the American Standards Association and president, Bristol Brass Corporation, Bristol, Conn. Mr. Gay welcomed delegates attending the opening session of the American-British-Canadian Conference on Engineering Standards, which was held in the Engineering Societies Building, New York, N. Y., April 11–15, 1955.

The consensus was that some of the most important achievements of the conference were the development of mutual understanding and better communication. Leaders of all the delegations referred, in the closing session, to the facts and ideas "that we will take home to think about."

Delegates Voice Opinions

Speaking at a press conference after the opening session, Stanley J. Harley, chairman of the British delegation and chairman of the Engineering Divisional Council of the British Standards Institution, emphasized that the most effective provision for defense would be utilization of the Screw Thread Standards as "part of the normal production process" by engineers of the participating nations. Mr. Harley cited the existing differences in gaging practice and inspection procedures as one area which merits special attention. Plating of bolts, he said, is a problem: Should gaging take place before or after plating?

It was also pointed out by Col. Arthur N. Huddleston of the Canadian Department of National Defense, that increasing commercial interdependence renders such standardized production more and more practical. For example, a recent advertisement of the British-made Anglia, intended for American consumption, plays up "American-size bolts, nuts . . . no foreign tools needed."

Admiral George F. Hussey, Jr., managing director and secretary of the American Standards Association, noted the presence at this meeting of delegates from such distant parts of the world as Australia, New Zealand, Pakistan, Union of South Africa, and India. He observed that the English-speaking countries are "inch-using countries" (as opposed to those using the metric system of measurement) and that these countries therefore share the same problems.

Screw-Thread Gaging. The gaging of screw threads was the chief subject for discussion at this conference and occupied nearly three full days of discussion. A series of British documents offering proposals and suggestions for unifying gaging practices was examined, item by item, and compared with the American and Canadian positions. No substantial agreement was reached on gaging unification, but a thorough understanding of the reasons for the position of each country was clarified. The principal points of difference were the amount of gage tolerance, the disposition of the tolerance zones, the wear allowance for gages, and the method of use of GO reference gages. The United States announced its intention to study the United Kingdom proposals further and the UK promised to comment at length on the newly published Par. 24 of the proposed revision to ASA B1.1 Unified and American Screw Threads.

Surface Finish. It was agreed to include a note in American, British, and Canadian standards to the effect that although the respective standards differed somewhat in form and content, measurements taken in conformity with each standard would give substantially the same result, and that in this sense the standards were unified.

Microscope Objective Threads. The only difference in the ABC standards was found to be that the American practice was to truncate the thread crests, whereas British favored rounded crests. The threads, however, are fully interchangeable. This interchangeability will be expressed in each standard, together with a note which warns of the gaging problem that will be encountered because of the above difference in crests.

Bolts and Nuts. It was agreed to add to the unified series several other sizes in the hexagon series.

Limits and Fits. It was found that in diameters up to 20 in., the American, British, and Canadian standards (or revisions of standards) are in agreement. This will be stated in the standards. Further investigation will be made in the hope of achieving agreement on diameters above 20 in.

Other subjects discussed during the five-day meeting were terminology, miniature ball bearings, interference-screw fits, and gas-cylinder threads.

Plans for Future Conferences

Correspondents in each country will be designated to exchange views on subjects of concern to the ABC countries and when any of these subjects are ready for discussion, an ABC conference will be called for that particular subject. Subjects for possible future unification include: Screw threads of the standard series; gaging of screw threads; the extension of the various series of unified threads; acme, buttress, gas-cylinder, and microscope threads; surface finish; the strength of screw threads in their application; bolts and nuts; the coating of screw threads; miniature threads; cylindrical limits and fits; miniature bearings; drafting practice; general principles of gaging; and definitions and terminology.

Social Events

Admiral Hussey turned a neat phrase at the dinner the American delegation gave in honor of the British and Canadian groups. He said that in view of all the discussion he had heard at the conference about ten thousandths and hundred thousandths of an inch, he was able to paraphrase Churchill and say that never before has so much been said about so little.

The social program included the ASME cocktail party for all attendees on Monday night; a cocktail party given by the British and Canadian delegations on Wednesday night; and a dinner the American delegation gave following the cocktail party. All the social functions where held in the Engineers' Club.

First ABC Conference in 1943

Under the impetus of the World War II emergency, the first ABC Conference on Engineering Standards was held in 1943, and since then similar meetings have been held every three years. A major achievement was adoption in 1948 of the Unified Screw Thread Standards specifying three basic sizes of screw threads for all armed-forces material manufactured in Great Britain, Canada, and the United States.

The 1955 Conference, which was called by the American Standards Association at the request of Arthur Flemming, Director of Defense Mobilization, was under the sponsorship of The American Society of Mechanical Engineers.

ASME Calendar of Coming Events

Sept. 12–14
West Coast Committee of the ASME Applied Mechanics Division, 1955 Western Conference on Applied Mechanics, U. S. Naval Post-Graduate School, Monterey, Calif.
(Final date for submitting papers was May 1, 1955)

Sept. 12–16
ASME Instruments and Regulators Division and Instrument Society of America Exhibit and Joint Conference, Los Angeles, Calif.
(Final date for submitting papers was May 1, 1955)

Sept. 25–28
ASME Petroleum-Mechanical Engineering Conference, Roosevelt Hotel, New Orleans, La.
(Final date for submitting papers was May 1, 1955)

Oct. 10–12
ASME-ASLE Second Lubrication Conference, Antlers Hotel, Indianapolis, Ind.
(Final date for submitting papers was June 1, 1955)

Oct. 19–20
ASME-AIME Joint Fuels Conference, Neil House, Columbus, Ohio
(Final date for submitting papers was June 1, 1955)

Nov. 13–18
Diamond Jubilee Annual Meeting, Hotel Congress, Chicago, Ill.
(Final date for submitting papers was July 1, 1955)

Nov. 14–18
Exposition of Power and Mechanical Engineering, as part of ASME 75th Anniversary Annual Meeting, Coliseum, Chicago, Ill.

IME Awards Igor Sikorsky 1955 James Watt International Medal

Dr. Sikorsky delivers Clayton Lecture before IME in London

"A BRIGHT and certainly an interesting future lies ahead for the helicopter," Dr. Igor Sikorsky, helicopter pioneer and aviation authority, has predicted in the Clayton Lecture delivered before the General Meeting of The Institution of Mechanical Engineers in London, England, on April 29. Dr. Sikorsky, a Russian-born United States citizen, received the Institution's James Watt International Medal.

On January 19 the Council of the Institution awarded the 1955 Watt Medal to Dr. Sikorsky in recognition of a lifetime of eminence in applying science to the progress of engineering through pioneering development of multi-engined airplanes, flying boats, and amphibians, to the first successful helicopter, uniquely serving mankind in war and peace.

Following the award of the medal, the Council invited Dr. Sikorsky to deliver, in London, a James Clayton Lecture entitled "The Transport Helicopter."

Development of the transport helicopter, he said, will follow two main lines for both military and commercial use: The first will correspond to the air liner or transport airplane, while the second will be a freight and cargo carrier.

Passenger Helicopter

The passenger models will continue to resemble air liners in interior arrangements with only minor variations such as large doors and windows. But in the freight-cargo helicopter Dr. Sikorsky foresees major changes which will result in a craft "with virtually no parallel in any other aircraft or even in any other vehicle of travel."

Cargo Helicopter

"The cargo helicopter may virtually have no fuselage body as we know it and may simply represent a flying frame or possibly have a needlelike fuselage of small cross section adequate to accommodate the transmission and other accessories, and either a hoist or other arrangement to lift the loads." In view of the remarkable feats already performed by conventional cargo helicopters, Dr. Sikorsky believes that with the incorporation of new design features, the potentialities are immense for direct delivery of a variety of materials in assembled, ready-to-use form.

He favors the single-rotor helicopter and believes that it will "remain the most important type" in the future, although "different methods of transmitting and applying power may be visualized." Some type of boundary-layer control would increase the efficiency of the pure helicopter, but use of supersonic blades would present considerable problems. The gyrodyne and the convertible helicopter, according to Dr. Sikorsky, are best suited to special tasks.

Piston engines or turbines combined with the present metal gear transmission will probably be used in most helicopters for a long time to come. Another alternative, especially for large-size machines, is "to eliminate the transmission and apply the force directly at the tips of the blades in the form of jets."

Nuclear Power for Helicopters

Dr. Sikorsky outlined several methods for utilizing nuclear power for helicopters. The factor of radioactivity would necessitate keeping the nuclear reactor and the turbines a considerable distance from crew and passengers, possibly in a unit carried separately. On the other hand, it might prove more practicable to carry crew and passengers in a cabin suspended from the helicopter. Advantages of using nuclear power, however, are not certain, because the helicopter is mainly a short-range aircraft.

Pointing to the enviable record established by helicopters in performing emergency rescues and other urgent errands during war and peace, Dr. Sikorsky said that the helicopter "will gradually assume the leading position as a guardian of life and property in emergencies of virtually any nature."

He is confident that the helicopter, although essentially a low-speed aircraft, will play a vital and practical role in the world of the future. On the side of speed, Dr. Sikorsky stated that without doubt the supersonic rocket-driven airplane is the forerunner of space craft which will open the prospect of space travel within the current century.

The James Watt International Medal, which was presented to Dr. Sikorsky in London on April 29, is considered one of the top awards in the field of engineering. The Institution of Mechanical Engineers requests nominations from engineering societies throughout the world, and Dr. Sikorsky was the nominee of The American Society of Mechanical Engineers. He is a Fellow of ASME and received the Society's Worcester Reed Warner Medal in 1943.

20,000 Key Engineers Listed for Emergency

ENGINEERS Joint Council has announced that it is assembling a "Finder's List" of key members of the profession throughout the nation who would assist in locating engineering talent needed in time of national emergency. The work is being done in co-operation with the National Science Foundation of Washington, D. C., which Congress directed to establish the National Register of Scientific and Technical Personnel. EJC has undertaken to maintain the engineering phase on a current basis.

Some 8000 of an expected 20,000 leaders in all branches of engineering have already been listed. These will be men of recognized standing whose experience or present positions enable them to know where engineering help may be found. Through these, in time of emergency requiring immediate location of experts in particular fields involved by the emergency, the Government will be able to contact those needed.

EJC is a federation of ten major national organizations with a total membership of 196-000. However, the rest of the approximately 500,000 engineers of the nation are equally represented in the Finder's List.

Several major scientific organizations have undertaken the registration of scientists, with an expected total approaching 200,000. This section of the Register will not be limited to a Finder's List but has as its objective the inclusion of all qualified scientists. The records, both as to engineers and scientists, will be maintained by the individual organizations with copies in the hands of the Foundation.

Second Annual ASLE-ASME Lubrication Conference to Stress Research

GREAT interest is being shown in the Second Lubrication Conference sponsored jointly by the Lubrication Activity Group of The American Society of Mechanical Engineers and the American Society of Lubricating Engineers, to be held October 10–12 at the Antlers Hotel, Indianapolis, Ind , and already 26 high-caliber papers have been submitted.

The large attendance at the first joint conference in Baltimore, Md., demonstrated the great interest in the field of lubrication research. As a result, three days instead of two will be devoted to the presentation and discussion of research papers at the 1955 conference.

As in the 1954 conference, there will be no conflicting sessions, and those attending will have the opportunity to hear the presentation of all papers. The practice of providing registrants with preprints of the papers to be presented will be continued.

Based on the great number of papers received, the conference will be divided into the following sessions: Bearing instability, recent studies in hydrodynamic lubrication, lubricants, rolling contact bearings, and boundary lubrication.

The ASME and ASLE committee promises that this will be an outstanding conference so be sure to make plans now so you can attend in the fall.

ASME Participates in U of U Heating and Ventilating Conference

BY INCREASING the health and comfort of their workers, businessmen can anticipate an increase in productive efficiency and a general improvement in the morale of personnel, John W. James, first vice-president of the American Society of Heating and Air-Conditioning

ASME Membership as of May 31, 1955

Honorary Members	68
Fellows	402
Members	14,350
Affiliates	302
Associate Members (33 and over)	3,790
Associate Members (30–32)	4,504
Associate Members (to the age of 29)	15,758
	39,174

Engineers, stated at the banquet on Friday, April 29, which concluded the Second Annual Conference on Heating and Ventilating sponsored by the University of Utah. This conference of Intermountain-area engineers was held in co-operation with The American Society of Mechanical Engineers and the American Society of Heating and Air-Conditioning Engineers.

In addressing the guests at the banquet, Mr. James, who is vice-president of McDonnell & Miller, Chicago, Ill., answered the question, "Does Air Conditioning Provide a Healthful Indoor Environment?" by discussing the importance of properly installed air conditioning as a health and comfort factor in business and industry. He pointed out that greater emphasis is obviously being placed on the importance of indoor year-round comfort, because most skyscrapers and other large buildings constructed today include air conditioning.

Luncheon Marks ASME Diamond Jubilee

Members of the Southern California Section of The American Society of Mechanical Engineers, one of the nation's oldest professional-engineering societies, launched the group's local observance of the ASME's 75th Anniversary Diamond Jubilee with a luncheon on May 2, at the Mayfair Hotel, Los Angeles, Calif.

Attended by engineers, educators, and industrialists, the luncheon included presentation of a "Man of the Year" award to W. L. Chadwick, vice-president in charge of engineering and construction for the Southern California Edison Company. David W. R. Morgan, President of ASME, principal speaker at the luncheon, made the presentation. L. F. Richardson, Bailey Meter Company, chairman of the Southern California Section, presided.

The luncheon was part of the nationwide commemoration of the Society's founding 75 years ago in New York, N. Y. The group's national membership, including some of the nation's top engineering brains, has passed the 40,000 mark. The Southern California Section of the pioneer group has more than 1800 members and ranks fourth nationally by city.

Prior to presenting Mr. Chadwick with the Man of the Year award, President Morgan told the audience that ASME has been one of the most important engineering groups in the nation. "For 75 years the society has exercised the group effort and group foresight that are so essential to America's enduring strength," he said. "This group effort has been basic to our living standard and has been basic to the productive strength that has preserved the right of people to enjoy or strive for human freedom."

In celebration of the Seventy-Fifth Anniversary of the Society, Mr. Morgan declared, we rededicate ASME—By Truth and by Service to Enrich Mankind.

The Southern California officers of the section, in addition to Mr. Richardson, are: R. M. Hatfield, Combustion Engineering-Superheater Inc., vice-chairman; F. J. Fontana, Richfield Oil Corp., secretary-treasurer. Members of the executive committee are: F. R. Adler, Hughes Aircraft Company; I. R. Caraco, Bechtel Corp.; J. S. Newton, Hydro-Aire Corp.; E. K. Springer, University of Southern California; J. V. Welsh, Fiberglas Corp.; M. A. Wise, General Petroleum Corp.

ASME Elects Fifteen Fellows . . .

The American Society of Mechanical Engineers has honored 15 of its members by electing them to the grade of Fellow of the Society.

To be qualified as a nominee to the grade of Fellow one must be an engineer with acknowledged engineering attainment, 25 years of active practice in the profession of engineering or teaching of engineering in a school of accepted standing, and a member of the Society for 13 years. Promotion to the grade of Fellow is made only on nomination by five Fellows or members of the Society to the Council, to be approved by Council.

The men, whose outstanding contributions to their profession and to the Society, who were so honored are:

Harold Tolman Avery

Harold T. Avery, vice-president, engineering, Marchant Calculators, Inc., Oakland, Calif., and vice-president and director, Marchant Research, Inc., is known for his developments and inventions in the field of calculating machines. Mr. Avery has directed the development of the Marchant line of calculators for the past 26 years. As chief engineer of his company he invented and directed the development of dozens of different models of calculators. A major development was his invention of the basically new type of calculating mechanism used in the Marchant silent speed calculator in 1933 and in all Marchant calculators since that date. In addition, he also supervises patent, research, and production-engineering activities for the company. Mr. Avery holds 62 U. S. patents relating to his work in calculators. He also holds seven U. S. patents relating to control and navigation of aircraft, under certain of which the Arma dead-reckoning indicator and Bendix air-position indicator have been manufactured. His other patents include 12 relating to helicopters, several of which have been licensed or sold to the Government, Autogiro Company of America, Minneapolis-Honeywell, and others. In 1940 Mr. Avery received the Modern Pioneer Award of the National Association of Manufacturers. He has been active in ASME affairs, serving as chairman of the San Francisco Section, 1941-1942, and as chairman, Regional Conference in 1942.

John Rowland Brown

John R. Brown, president and general manager, The Reliance Gauge Column Company, Cleveland, Ohio, has contributed to the design and manufacture of boiler controls and safety devices for steam generators. In his present position since 1919, he has been responsible for the development of a process of making seamless floats by electrodeposition, methods of welding floats, boiler alarms and accessories, and remote-level indicators. He designed and built a special device for the atomic submarine *Nautilus*. Mr. Brown developed the use of mica in place of glass for high-pressure water-level indicators for high-pressure boilers, in addition to methods for illumination of water-level indicators. His early achievements include design and development of one of the first water-tube superheaters and one of the first sectional boiler casings. Mr. Brown has also made contributions in the electrified-railway field. He designed and developed gas-weld rail bonds for electric railways and catenary systems. Another development was the overhead and return-circuit design for Chicago Milwaukee electrification through the Bitter Root Mountains. Mr. Brown holds 43 patents. He has been active in the ASME Cleveland Section, serving as chairman in 1926.

Jay Howard Cather

Jay H. Cather, superintendent of Power Division, Eastman Kodak Company, Rochester, N. Y., has been with his present company since 1912. He joined Eastman Kodak as an inspector of building and power equipment. He was made assistant engineer in 1914 and later chief engineer of construction and operation of the then entirely new Canadian Kodak Company plant at Toronto, Can. In 1919 he assumed his present post as superintendent of the Power Division where his responsibilities have included the design, development, maintenance, and operation of the total steam, power, refrigeration, and water requirements and other miscellaneous services for Kodak Park. In addition, he also serves as consulting engineer on steam and electric installations to Eastman Kodak plants throughout the world. Among other achievements, Mr. Cather installed the first reciprocating ammonia compressors for low-temperature work (—36 F) converting low-temperature absorption plant for this purpose. A pioneer in this field, he installed the first low-temperature refrigeration plant at —30 F and later at —36 F, during the 1920's. Mr. Cather also supervised a service water system with an average

The 13 men who received honorary Doctor of Engineering degrees Saturday, May 7, at the final Centennial convocation of New York University's College of Engineering are shown above with NYU's Chancellor Henry T. Heald, Mem. ASME, and Dean Thorndike Saville of the College. Ceremonies were held in the Gould Student Center at NYU's Bronx campus. *Left to right,* first row, are George Granger Brown, dean of engineering, University of Michigan; Maj. Gen. Hugh J. Casey, chairman of the New York City Transit Authority; William Francis Gibbs, Fellow ASME, president, Gibbs and Cox, Inc.; Michael Halpern, senior vice-president, The Texas Company; Chancellor Heald; Dean Saville; Alfred Iddles, Fellow ASME, president, The Babcock & Wilcox Company; Mervin Kelly, president, Bell Telephone Laboratories. Back row, *left to right:* Augustus B. Kinzel, vice-president, research, Union Carbide & Carbon Corporation; George P. Meade, manager, Gramercy Refinery, Colonial Sugar Company; Frank N. Piasecki, chairman of the board, Piasecki Helicopter Corporation; Donald A. Quarles, Assistant Secretary of Defense; William T. Schwendler, executive vice-president, Grumman Aircraft; Alex Stewart, director of research, National Lead Company; and Julius A. Stratton, vice-president and provost, Massachusetts Institute of Technology. Dr Stratton delivered the convocation address.

peak consumption of 30 million gal per day. Another achievement is the design and installation of a central distilled-water system.

Montrose Keller Drewry

M. K. Drewry, chief engineer of power plants, Wisconsin Electric Power Company, Milwaukee, Wis., has been with his present company for 30 years. His engineering achievements have been in the field of modern power plants. Mr. Drewry joined the company as test engineer of power plants in 1924 and was successively technical engineer of power plants and assistant chief engineer of power plants. In 1948 he was appointed to his present position. Mr. Drewry's company is known for its extensive application of pulverized coal and higher steam pressures for economy in power production and for its greatly expanded power-production capacity. In his work Mr. Drewry had a part in this entire development in designing larger and more efficient boiler units, and in making the modifications for operating under higher temperatures and pressures to attain greater economies of operation. Total generating capacity of the three major power plants operated by his company in 1924 was 120,000 kw. At present the combined capacity of the five major plants is 1,050,000 kw. Mr. Drewry received the ASME Junior Award in 1931. He has been active in the ASME Milwaukee Section. Mr. Drewry has written several papers about power production. He holds several patents.

Vivian F. Estcourt

Vivian F. Estcourt, general superintendent of steam generation, Pacific Gas and Electric Company, San Francisco, Calif., has made engineering contributions in the design, operation, and management of steam-electric power stations. His first connection with his present company was in 1917, prior to his graduation from Stanford University. After serving with the Armed Forces in World War I, he returned in 1923 as efficiency engineer in a steam plant. He served as assistant superintendent of the steam department, assistant engineer of operation, engineer of steam and gas, and in 1950 was made general superintendent in charge of steam generation. His responsibilities in this position have included management and operation of the company's steam-electric generating facilities which have grown from an installed capacity of 1,200,000 kw in 1950 to 3,000,000 kw in 1955. His duties include consultation and departmental approval in connection with with new steam-plant design. During his career, Mr. Estcourt has had major responsibility for the operation of many new company installations. During 1931-1932 he was engaged in the operational development of one of the earliest 1400-psi 750/750 F reheat stations in the nation and the first on the Pacific Coast. He has made a major contribution to engineering in the development of very fast load-pickup performance and wide load-range operation in a reheat station, and several basic improvements in the design of combination oil and gas burners. Mr. Estcourt is a past-chairman of the ASME San Franciso Section and was recently awarded the Society's 75th Anniversary Medal for his "services in advancing the engineering profession as the member of the San Francisco Section who has done most to further the aims and objectives of the Society." He is the author of many technical papers in his field.

Herbert Williams Faus

Herbert W. Faus, an engineering graduate of Syracuse University and retired engineer of locomotive equipment, White Plains, N. Y., has spent 37 years in the railroad industry, mainly with the New York Central Lines. After five years' experience on the Canadian Northern and Canadian Pacific railways in British Columbia, he joined New York Central in 1915 as special engineer in the office of the assistant to the president. From 1917 to 1923, by special request, he was employed by the U. S. Shipping Board, Emergency Fleet Corporation. Rejoining New York Central in 1923, he was successively special engineer, office of chief engineer, motive power and rolling stock; engineer of materials and

equipment tests; and engineer of tests. From 1937 to 1953 he was successively engineer of motive power and engineer of locomotive equipment responsible for design and construction of new steam locomotives and engineering standards of locomotive maintenance. Mr. Faus was chairman of the American Society for Testing Materials Committee that wrote the first precise, and now universally accepted, definition of wrought iron. In 1925–1926 he prepared a report on locomotive-boiler waters on the New York Central which revolutionized water-treatment practices on that road and resulted in large savings. From 1929 to 1953 he actively participated in the establishment of present Association of American Railroads' specifications and standards for couplers and draft gears for railroad cars and locomotives and was chairman of the Committee on Couplers and Draft Gears from 1946 to 1953. From 1934–1953 he actively participated in the establishment of present specifications and standards for freight-car trucks. He holds many patents including one on a hot-bearing alarm that is now in use by more than 130 railroads in the United States and abroad. He is the author of several papers in his field.

Charles Winfred Good

Charles W. Good, professor of mechanical engineering, University of Michigan, has made contributions to engineering in the field of internal-combustion engines. He has had a long career inteaching, research, consulting engineering, and the administration of research. He joined the University in 1918 as an instructor in auto mechanics and became professor of mechanical engineering in 1943. In addition to teaching, he served as assistant director of the department of engineering research and of its successor, the Engineering Research Institute, from 1936 to 1951. His studies of combustion in internal-combustion engines led him to predict the difference in burning conditions with detonating and with nondetonating combustion in spark-ignition engines and to show that some of the power loss with detonation was due to kinetic-energy effects rather than heat conductance alone. The textbooks on internal-combustion engines which he coauthored were used for 20 years at the University of Michigan. He served as engineering consultant to the American Car and Foundry Company, New York, N. Y., which contracted with the Atomic Energy Commission for the mechanical design of certain thermonuclear test devices, assisting in their design, production, erection, and testing, 1951–1953. He has been active in ASME affairs, serving as chairman, Oil and Gas Power Division, 1940–1941; chairman, Professional Divisions Committee, 1953; and as a member, Board on Technology, 1953. He is coauthor of "Internal Combustion Engines," with W. E. Lay, 1931, and with W. E. Lay and E. T. Vincent, 1944.

Harry Reginald Kessler

Harry R. Kessler, manager, New York Office, Republic Flow Meters Company, Chicago, Ill., has been active in automatic control and instrumentation for the process and public-utility industries. Mr. Kessler, after serving for several years as test engineer at the United Electric Light & Power Company of the Consolidated Edison System, joined the staff of Smoot Engineering Corporation of New York in 1923, a company specializing in the field of automatic-combustion control. After several years in the service department of the company, he became chief engineer of the Contract Division. In 1934 he became associated with Republic Flow Meters when this company acquired the Smoot Engineering Company. Mr. Kessler has maintained an interest in the field of automatic-combustion control since its modern inception and has contributed in many ways to its progressive development. He has contributed much in the field of high-pressure steam flow through valves by research studies which were started under his direction to eliminate noise and vibration. This research resulted in outstanding improvement in the operation and design of these valves. He has contributed to the art of proportional measurement of combustion air to accommodate the simultaneous burning of multiple fuels in a common furnace. Mr. Kessler served with the American delegation of the Engineers Joint Council in the writing of the constitution of the Union Panamericana de Asociones de Ingenieros (UPADI) in Havana, Cuba, in 1951. He served as Vice-President of ASME Region II and is a member of the ASME Council, serving a second term. He has served as chairman of the Fuels Division and as chairman of the ASME Metropolitan Section. At present he is a member of the Finance Committee of the Society and chairman of the Publicity Committee of the Metropolitan Section. He was awarded the ASME 75th Anniversary Medal "for professional contributions to the public welfare" by the Metropolitan Section on May 24, 1955. He is a joint patentee on boiler-feedwater-pump control.

Max H. Kuhner

Max H. Kuhner, vice-president in charge of engineering, Riley Stoker Company, Worcester, Mass., has contributed to engineering in the field of design of steam-generating and fuel-burning equipment. Mr. Kuhner was one of a group of engineers in charge of the design of the first commercial natural-circulation boiler constructed for 100 atmospheres (1500-psig operating pressure) constructed by Hanomag, Hanover, Germany, in 1921–1923. In 1925 he developed a new automatic paper-folding machine for the Hill-Curtis Company, Kalamazoo, Mich., which is still being produced and is standard equipment for progressive printing shops. Mr. Kuhner originated bare-tube waterwalls for pulverized coal-fired furnaces and successfully applied them for the first time in the new power plant of Aberfoyle Manufacturing Company in 1926. He originated the idea of housing large boiler units in completely airtight steel-cased settings to eliminate refractory wall structures and to prevent the losses previously caused by the infiltration of uncontrolled air. In his present position with Riley Stoker Company, he is responsible for the development and design of the company's products in the fields of fuel burning and steam generation. He guided the engineering work for such installations of steam-generating units as the 1,250,000-lb capacity reheat for the Valley Stream Station, Los Angeles, Calif., and others. He developed the special designs of steam-generating units required for spinning-load and quick-load pickup. He developed the design of steam-generating equipment especially adapted for steel-mill plants. Mr. Kuhner has written many papers and technical articles. He holds close to 100 patents in the power field.

James Noble Landis

James N. Landis, vice-president, Bechtel Corporation, San Francisco, Calif., is known for his achievements in the steam-electric power-plant field. From 1923 to 1936 he was employed by the Brooklyn Edison Company, Brooklyn, N. Y., in various engineering positions leading up to mechanical engineer. In 1937 he was transferred to the Consolidated Edison Company of New York as manager of the newly organized contract control and inspection department. In this capacity he was responsible for specifying, ordering, receiving, and installing all generating-station equipment on the Consolidated Edison Company System. From 1938 to 1948 he was assistant mechanical engineer, responsible for structural and mechanical layout and engineering design of all power-plant installations on the Edison system. He joined the Bechtel Corporation in 1948 as chief power engineer. He was in charge of all engineering, layout, and design of steam-power plants ranging in size from 5000 kw to 625,000 kw. This included such plants as Contra Costa, Pittsburg, and Morro Bay for Pacific Gas & Electric Company; Gadsby and Carbon for Utah Power & Light Company; Kyrene for Salt River Power District of Phoenix; and El Segundo for Southern California Edison, aggregating about 2,250,000 kw of installed capacity. In 1951 he became active in the Pacific Gas & Electric-Bechtel Industrial study on the feasibility of atomic power for the generation of electricity, and for the past two years has served on the expanded study team known as the Nuclear Power Group. Mr. Landis has been active in ASME affairs, serving on many Standing and Special Council Committees through the years 1932 to 1945. He has also been chairman, Metropolitan Section, 1933–1935; chairman, San Francisco Section, 1953–1954; and Director-at-Large, 1945–1949. Currently he is a member of the Committee on Practice of Consulting Engineering and of several committees in the newly formed Nuclear Engineering Division. He has written many technical papers relating to the steam-power-plant field.

John P. Magos

John P. Magos, director of engineering and research, Crane Company, Chicago, Ill., has been with his present company since 1923. From 1925 to 1935 he was testing engineer, assistant to manager of tests, and then en-

gineer in charge of design and testing of heating products. During this period he was awarded many patents on heating products. From 1936 to 1945 he was engineer in charge, directing engineer, and finally director of research of the research and development laboratories. In addition to greatly expanding the research laboratories, he supervised developments for heat-transfer devices, air-conditioning units, government projects; e.g., means of combating gun-barrel erosion. Since 1946 he has been director of engineering and research in charge of the Engineering Division. Developments, under his supervision, of new products included diaphragm valves, pipe-line valves, pressure-seal bonnet joints, dial-ese trim for plumbing fixtures, improvements in home-heating boilers, jet-heat units for home heating, and developments of ideas and facilities for formation of subsidiaries for the production of titanium and rare earths. Mr. Magos received the Naval Ordnance Development Award, 1945; the War Department Certificate of Appreciation, 1945; and the Presidential Certificate of Merit, 1948. He has served the Society on the ASME Nominating Committee, 1944; and as chairman of the Chicago Section, 1943–1944. He holds many patents.

David Nabow

David Nabow, vice-president and chief engineer, and member, executive committee of the board of directors, Duke Power Company, Charlotte, N. C., has been active in the economical design of large steam-electric and hydroelectric generating stations with the Duke Power System since 1925. During his career, Mr. Nabow has been chief design engineer or consultant in the construction of approximately 26 hydroelectric and steam installations in the United States and Canada, including the 360,000-kw Isle Maligne Hydro-Electric Plant (Canada) and the 665,000-kw Riverbend Steam Plant of the Duke Power Company. The new steam-power-plant units, designed under his direct supervision and placed in service since 1948, have a total capability of 1,260,000 kw. This included the Lee Steam Station listed by the Federal Power Commission in 1952 as one of the eight most efficient stations. His current work covers a 350,000-kw initial installation at the Allen Steam Plant and a 150,000-kw addition to the Dan River Steam Station. In addition, Mr. Nabow is regularly engaged in managerial, financial, and policy-formulating activities as a member of the executive committee of the board of directors of his company.

James Frank Roberts

James F. Roberts, vice-president and director of engineering, General Machinery Division, Allis-Chalmers Manufacturing Company, Milwaukee, Wis., has made important contributions in the field of water development here and abroad. He joined the staff of the hydraulic department of Allis-Chalmers as a test engineer in 1918, carrying out tests on large hydroelectric units. In 1927 Mr. Roberts became associated with the Power Corporation of Canada in Montreal as a hydraulic engineer. He was in charge of engineering design and installation of hydroelectric machinery for six plants and 20 units scattered over Canada. For seven years, beginning in 1935, he served as principal mechanical engineer and head hydraulic engineer of the Tennessee Valley Authority. This work covered the selection, specifications, purchase, and installation of about 36 hydroelectric units in 12 different plants, many of these units being the largest in the U. S. He rejoined the Allis-Chalmers Company in 1941 as manager of the hydraulic department. He was appointed to his present position in 1951. This position includes the co-ordination and technical supervision of all engineering design work by the various divisions of the General Machinery Division. It also includes supervision of standardization, field service and erection, and new developments in connection with the Atomic Energy Commission and other government research projects. He served the ASME as chairman of the Hydraulic Division, 1948–1949. He holds several patents on developments in hydroelectric machinery. Mr. Roberts has written several papers in this field.

Otis Daniel Treiber

Otis D. Treiber, consulting engineer, Canton, Ohio, is known for his work in the development of lightweight, high-speed heavy-duty diesel engines. In his early career he designed and built passenger boats and side-wheel double-end automobile ferries. In 1914 he designed and supervised building of a double-end propeller-driven 24-auto ferry for King County (Seattle), Wash. This is said to be the first diesel-powered ferry boat ever built and the first all-American designed and built diesel engine. In 1915 he designed and built the coastal freighter *Apex* which is said to be the first American commercial diesel-powered freighter. He designed and "airless or solid fuel-injection system and apparatus for diesel engines." This was perfected and put into production in Oakland, Calif., in 1920, to become the world's first successful solid-injection diesel engine and was used throughout the world. It is still used with some refinements and modifications on all diesel engines. From 1921 to 1925 he designed and supervised construction of approximately 25 models of diesel engines for Bessemer Gas Engine Company, Grove City, Pa. These included the world's first Vee-type diesel engine of 500-hp for switch locomotive on the Pennsylvania Railroad. From 1925 to 1930 he was president and chief engineer of Treiber Diesel Engine Company. During this period he designed and developed the lightweight high-speed diesel engine (over 750 rpm). Engine rpm speeds of some sizes were attained of 2000 rpm; considered impossible throughout the world at that time because of the injection and combustion problems. Thirteen models were developed including the world's first radial diesel engine and the world's first 12-cylinder Vee-type diesel engines. During the period 1930–1954 he developed the Hercules spherical high-speed diesel-engine combustion chamber and other items of engine construction. In 1945-1946 he was head of a group of 12 scientists and specialty automotive engineers who made a survey of the status of all engineering phases of the automotive industry in Germany. For this he received a "Certificate of Appreciation" from the Department of the U. S. Army. He was a member of the ASME Internal-Combustion Engine Power Test Code Committee which wrote the present I.C.E.I. Code, 1939–1949. He has written many papers and holds many patents, both U. S. and foreign.

Leslie Swales Wilcoxson

Leslie S. Wilcoxson, vice-president in charge of the Boiler Division, The Babcock & Wilcox Company, New York, N. Y., has contributed to the general development of boilers, furnaces, and component equipment. Mr. Wilcoxson became associated with his present company in 1926, performing general engineering work relating to design and operation of boilers and furnaces. Later he organized and controlled the Patent Division within the company. From 1931 to 1945 he was executive assistant to the vice-president in charge of engineering. During this period he was responsible with G. H. Tomlinson for the development of an improved process for recovering heat and chemicals in the alkaline-pulping industry and developed the recovery boiler and furnace used with the process. He helped to develop a new process utilizing magnesite bisulphite for the acid-pulping process, and also the recovery units for use in the process. Mr. Wilcoxson worked on the development of coal pulverizers and their application to steam boilers for power generation and their application in the process industries. He was active in the development of coal-fired, high-pressure steam-electric locomotives. He was also active in the general development of high-capacity, high-pressure boilers and furnaces, with particular emphasis on fuels and their utilization. In 1945 he organized the Company's research department and developed new laboratories now known as The Babcock & Wilcox Research Center at Alliance, Ohio. The same year he was elected vice-president of the company. Until April, 1955, he was responsible for research and development of products for all divisions of the company. In April he was appointed to his present position. He holds nine patents and is the author of many technical papers.

National Machine Tool Show, Chicago, Sept. 6-17

The 1955 National Machine Tool Show will be held in Chicago, Ill., at the International Amphitheatre, from September 6th to the 17th. A new Exposition Hall has been added to the Amphitheatre to accommodate the show. Exhibits at the show will be confined entirely to machine tools.

Simultaneously with the Machine Tool Show, a Production Engineering Show will be held on the Chicago Navy Pier. This show will display mechanisms, instruments, and equipment that contribute to greater automaticity of production and processing.

ASME Regional Administrative Committees

Region I, Brown University, Providence, R. I., May 7, 1955

Region II, Elks' Club, Elizabeth, N. J., May 2–3, 1955

Region III, Traylor Hotel, Allentown, Pa., March 30–31, 1955

Region IV, Monticello Hotel, Charlottesville, Va., April 2–3, 1955

DURING March, April, and May of this year the eight Regional Administrative Committees of The American Society of Mechanical Engineers met to discuss, with the Vice-Presidents, various Regional and Society problems; to express Regional views on the National Agenda; and to provide representatives of Sections an opportunity to further the nominating procedure for national offices.

The present procedures have evolved from long experience with various methods of bringing representatives of the Sections together. Delegates from Sections first met at the 1915 Spring Meeting in Buffalo, N. Y.—two representatives coming from each of then 15 Sections.

The Annual Conference started originally in 1916 and continued until 1931. The Sections had previously been grouped into seven groups for the purpose of selecting members of the Society Nominating Committee and in 1932 the Annual Conference was replaced by seven regional conferences using the same grouping used for Nominating Committee selection. A single delegate from each region attended a conference at the Annual Meeting. In 1935

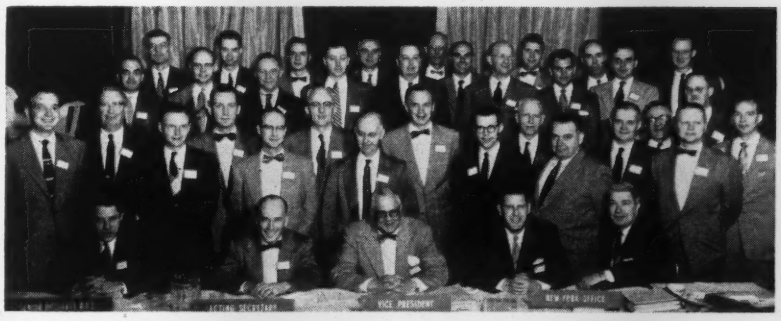
Held Meetings During March, April, and May

the delegates from the regions were increased to two each, each serving overlapping terms of two years, and the Annual Conference was moved to the Semi-Annual Meeting.

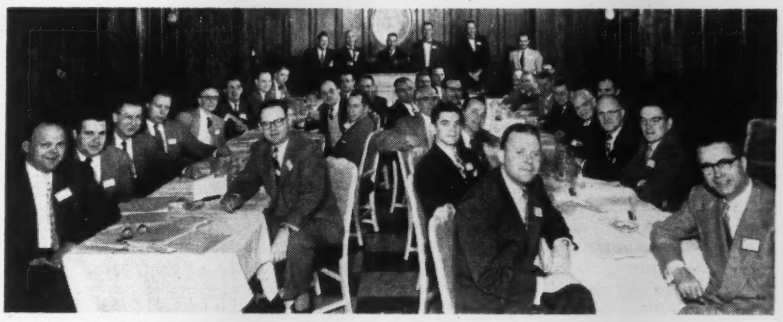
In 1940 the number of regions was increased to eight. The following year the Vice-Presidents were assigned regional responsibilities and the present Regional Administrative Committees came into being, made up of two representatives of each Section. At the same time the Regional Delegates Conference was formalized.

The RAC meetings are held each year during March, April, or early May. The place is decided at the preceding RAC meeting or by the Vice-President. The date is arranged among the Vice-President, the Host Section, and the Secretary's office and confirmed at a meeting of Vice-Presidents.

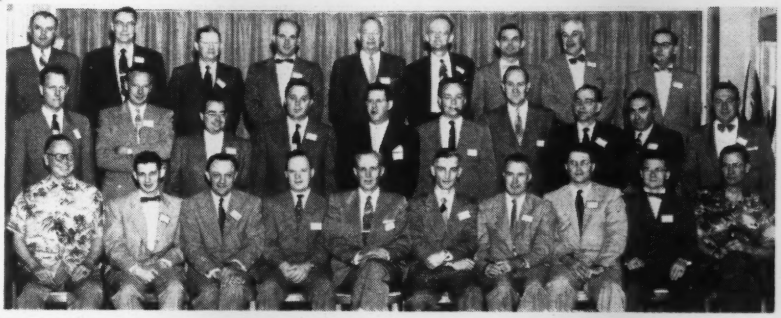
Shown on these pages are the Regional Administrative Committees who met this year. A report on the 1955 Regional Delegates Conference, held during the Diamond Jubilee Semi-Annual Meeting in Boston, Mass., June 19–23, will appear in a forthcoming issue of MECHANICAL ENGINEERING.



Region V, Pick-Ohio Hotel, Youngstown, Ohio, April 4–5, 1955



Region VI, Gatesworth Hotel, St. Louis, Mo., March 25–26, 1955



Region VII, Claremont Hotel, Berkeley, Calif., April 29–30, 1955

Region VIII, Rice Hotel Houston, Texas, April 24, 1955

Representatives of engineering societies who attended the Council of Engineering Society Secretaries meeting in Philadelphia, Pa., May 24–25

Engineering Society Secretaries Confer in Philadelphia

THE Council of Engineering Society Secretaries held its nineteenth annual meeting at the Engineers' Club of Philadelphia (Pa.), May 24–25, 1955. More than 50 representatives of nearly 40 engineering societies and clubs met to discuss administration, publications, development of meeting programs, and the various other problems which enter into the operation of these organizations.

The engineering societies which compose the Council represent a membership of more than 500,000, thus making it the largest active representative engineering group working toward unity, both in the matter of operation and in objectives for the betterment of the engineering profession. With time out for the war effort, this organization has been active for 30 years. Its board of directors is made up of a balanced group, including representatives of the national, state, and local engineering societies and clubs.

At the luncheon on Tuesday, May 24, officers of the Philadelphia Convention and Visitors Bureau outlined reasons why the engineering profession should accept the City's invitation as a site for the new engineering headquarters. The invitation is supported financially by Philadelphia, its various industrial concerns, and many engineering firms and engineers.

The following day, K. H. Platt, assistant secretary of The Institution of Mechanical Engineers in London, England, was the principal speaker at the luncheon. Mr. Platt is spending several months in the United States investigating the operational methods of the various engineering organizations.

Panel Discussions

The discussions were conducted in four panels covering the following topics: (1) Publication techniques and problems regarding circulation, production, and selling; printing and distribution; solicitation of advertising; preprints and reprints; directories; and manuals of procedure for officers and committees. (2) Co-operation between local clubs and local sections of national societies. (3) Preparation of budget, financial control, increased operating costs of meetings, what a member should get for his dues, pension plans and insurance, job classification for staff, and securing industry support. (4) Intersociety relations, membership campaigns, collection of dues, employment service, student recruitment, public relations, and city and state property taxes as they apply to society holdings.

Officers Elected

The following officers were elected for the coming year: J. Earl Harrington, president; T. J. Ess, vice-president; C. S. Doerr, secretary; W. P. Youngclaus, Jr., treasurer. The directors elected are: W. H. Evans, until 1958; A. R. Putnam, until 1957; and E. H. Robie and L. Austin Wright, who were both elected for a one-year term.

At the concluding session of the meeting it was voted to hold the next meeting in Cincinnati, Ohio, July 9–11, 1956.

People. . .

HARRY A. KULJIAN, Fellow ASME, president, The Kuljian Corporation, Philadelphia, Pa., received the "Engineer of 1954" Award from the Philadelphia Chapter of the Pennsylvania Society of Professional Engineers, at a luncheon in his honor.

C. FAYETTE TAYLOR, professor of automotive engineering, Massachusetts Institute of Technology, participated in the International Internal-Combustion Engine Congress held at The Hague, The Netherlands, from May 23 to 28. The only contributor from the United States, his report is based on research carried out over the past ten years in the Institute's Sloan Laboratories for aircraft and automotive engines.

DAVID L. ARM, Mem. ASME, dean of the school of engineering at the University of Delaware, has been appointed manager of the industrial department of the National Safety Council.

L. R. HAFSTAD, who retired recently as director of the Atomic Energy Commission's Division of Reactor Development, has been granted the AEC's Distinguished Service Award.

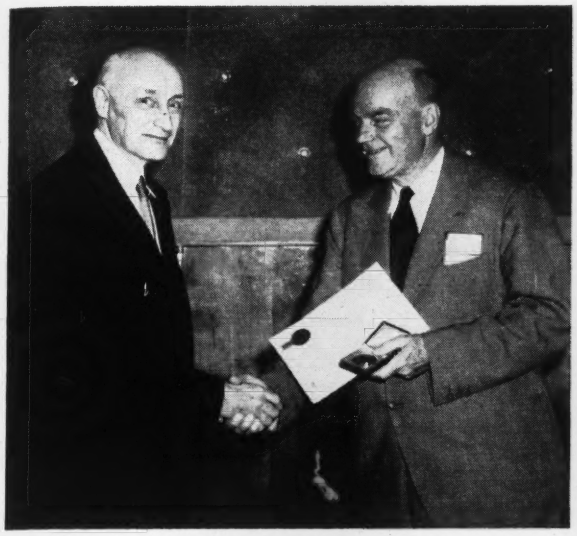
C. G. A. ROSEN, Fellow ASME, consulting engineer, administrative department, Caterpillar Tractor Company, Peoria, Ill., took office as president of the Society of Automotive Engineers for 1955, on January 14, during SAE's Golden Anniversary Annual Meeting.

William Dubilier, founder of the Cornell-Dubilier Electric Corporation, South Plainfield, N. J., was the first recipient of Cooper Union's Alumni Association Gano Dunn Award, Feb. 12, at the Commodore Hotel, New York, N. Y. Mr. Dubilier was honored by his alma mater for his inventions and development of high-voltage condensers, which helped the tremendous growth of the electrical and electronic industries.

M. D. HOOVEN, Mem. ASME, Public Service Electric and Gas Company, Newark, N. J., has been nominated as the 1955–1956 president of the American Institute of Electrical Engineers.

R. E. HEARTZ, Hon. Mem. ASME, president, The Shawinigan Engineering Company, Ltd., Montreal, Can., and member of the management committee of the parent Shawinigan Water and Power Company, has been chosen as president of The Engineering Institute of Canada.

Awards and Honors. RAY P. DINSMORE, vice-president in charge of research and development for Goodyear Tire and Rubber Company, has been chosen to receive the Charles Goodyear Medal for 1955 by the Rubber Division of the American Chemical Society. The award will be presented at the Bellevue-Stratford Hotel in Philadelphia, Pa., during the annual meeting of the organization in November.



Frederick W. Lucht, Jr., *right,* Mem. ASME, development engineer of the Carboloy department of the General Electric Company, Detroit, Mich., receives an ASME 75th Anniversary Medal from J. W. Parker, past-president and Hon. Mem. ASME, at the annual Power Meeting of the ASME Detroit Section held on May 20, 1955. This medal, awarded for services which contributed toward the advancement of the engineering profession, is given the member of a Section who has done most to further the aims and objectives of the Society in celebration of the Diamond Jubilee Year.

Officers of Association of Engineering Colleges: Warren L. McCabe, *left,* Mem. ASME, administrative dean of the Polytechnic Institute of Brooklyn, who is the newly elected president of the Association of Engineering Colleges of New York State, and Brother Amandus Leo, dean of the School of Engineering at Manhattan College, who was elected secretary of the Association for the ninth consecutive year. The election of officers took place at the Association's semi-annual meeting held at the Polytechnic Institute of Brooklyn, April 23, in honor of the Institute's current centennial-year celebration.

ERNEST R. BREECH, chairman of the board of Ford Motor Company, received the 1955 American Society of Tool Engineers Progress Award at the Society's annual banquet held in Los Angeles, Calif., March 17. FRED H. COLVIN, Fellow ASME, editor emeritus, *American Machinist,* was awarded the 1955 ASTE Gold Medal, and O. B. JONES, president and founder of the Detroit College of Applied Science, received the Joseph A. Siegel Memorial Award.

WILLIAM H. BYRNE, vice-president, ASME Region II, president of Byrne Associates, New York, N. Y., was among the five leading engineering executives elected to membership in the Tau Beta Pi, honorary fraternity, at the Polytechnic Institute of Brooklyn, April 30.

JOHN CHIPMAN, head, department of metallurgy, M.I.T., was recipient of the 1955 Bessemer Gold Medal awarded by The Iron and Steel Institute of Great Britain. The medal is the greatest distinction the Institute bestows.

LILLIAN M. GILBRETH, Hon. Mem. ASME, received the honorary DS degree at the University of Wisconsin commencement ceremonies June 17. In April of this year she received a Freedoms Foundation Award for her article, "Girl Scouting—One Answer to Communism." Dr. Gilbreth has been interested in Girl Scouting since 1930 and is presently a member of the Girl Scout National Advisory Council.

RALPH M. HARDGROVE, Fellow ASME research consultant to The Babcock & Wilcox Co. of Alliance, Ohio, has been named 1955 recipient of the Benjamin G. Lammé Medal of Ohio State University. Presentation of the gold medal, one of the university's top awards, was made at the commencement exercises on June 10, in the Ohio Stadium.

ROBERT P. MESSENGER, Mem. ASME, vice-president, International Harvester Company, Chicago, Ill., was the recipient of the Cyrus Hall McCormick Gold Medal award on June 14 by the American Society of Agricultural Engineers at the annual meeting held at Illini Union, Urbana, Ill.

MAURICE NELLES, Mem. ASME, director of research and diversification, Technicolor Motion Picture Corporation, received an honorary DS degree from the University of South Dakota on June 6. He was the recipient of an honor conferred on an outstanding alumnus by the University only once every five years.

EARL C. PAYNE, Fellow ASME, consulting engineer, Pittsburgh Consolidation Coal Company, Pittsburgh, Pa., and JULIAN E. TOBEY, Fellow ASME, president, Appalachian Coals, Inc., Cincinnati, Ohio, two of the coal industry's outstanding engineers, received 1955 annual awards from Bituminous Coal Re-Research, Inc., for their contributions to industry-sponsored coal research. A. A. POTTER, Hon. Mem. ASME, president of BCR, made the presentations at the national research association's annual meeting at the William Penn Hotel, Pittsburgh, Pa., April 13.

THEODORE VON KARMAN, Mem. ASME, chairman NATO Advisory Group for Aeronautical Research and Development, Paris, France, was among the 14 world-renown scientists appointed to the Pontifical Academy of Science by Pope Pius XII. The Academy, founded under another name in 1603, is composed of 70 academicians.

CLYDE E. WILLIAMS, Mem. ASME, president and director of Battelle Institute, received an honorary LLD degree from Marietta College, Marietta, Ohio, at its Founder's Day Convocation.

Founder Societies. ERNEST KIRKENDALL was appointed secretary of the American Institute of Mining & Metallurgical Engineers as of February 15, to succeed EDWARD H. ROBIE who was appointed secretary emeritus on a full-time basis. Mr. Robie will also serve as secretary pro tem of the Mining Branch.

The American Society of Civil Engineers announced the appointment of WILLIAM H. WISELY as its executive secretary. He succeeds WILLIAM N. CAREY, who is retired. Mr. Wisely has been associate secretary of the society. He was previously executive secretary and editor of the Federation of Sewage and Industrial Wastes Associations.

WALTER J. BARRETT of Glen Ridge, N. J., has been installed as president of the United Engineering Trustees, Inc. Mr. Barrett, who is electrical co-ordination engineer, New Jersey Bell Telephone Company, Newark, N. J., has been a member of the Board of Trustees for

Morris Cook, *right,* vice-president of Bell Telephone Laboratories and National Councilor of Sigma Tau, presents Merit Award Plaque to Walter Wohlenburg, Fellow ASME, Dean of Engineering, Yale University. The presentation took place in New York, N. Y., on March 4. On May 5 Dean Wohlenburg received the Yale Engineering Association Award for Meritorious Services to Yale University at the YEA annual meeting held at the Yale Club, New York N. Y.

four years, serving as vice-president and on various committees, including finance. He becomes president of the United Engineering Trustees, Inc., at a particularly critical time when a new and larger engineering center is being considered. Various cities other than New York are offering attractions to lure the engineering headquarters to leave New York. Mr. Barrett represents the American Institute of Electrical Engineers on the Board of Trustees and is treasurer and a director of the Institute. He is also a director of the Engineers Joint Council.

E. Paul Lange, assistant secretary of Engineers Joint Council since May, 1954, became secretary of EJC on April 1, 1955. He succeeds Brig. Gen. Stewart E. Reimel, USA (Ret.), of Washington, D. C. General Reimel, who is secretary of the EJC Committee on International Relations, assumed on a temporary basis the additional duties of EJC's secretary fifteen months ago.

Other Societies . . . Herbert F. Roemmele, Mem. ASME, dean of students, The Cooper Union, became president of the New York State Society of Professional Engineers on June 1. Lois G. McDowell, Assoc. Mem. ASME, assistant professor of mechanical engineering, Illinois Institute of Technology, was recently elected president of the Society of Women Engineers. Harry B. Osborne, Jr., technical director, TOCCO Division, Ohio Crankshaft Company, was elected president of the American Society of Tool Engineers. Frank W. Reinhart, chief of the organic plastics section, National Bureau of Standards, was elected president of the Society of Plastic Engineers. Norman Anderson, president, General Molded Products, Inc., Des Plaines, Ill., is 1955–1956 president of the Society of the Plastic Industries. Raymond Foulkrod, chief engineer, Michigan Bell Telephone, was re-elected as a director and elected as president of the new Engineering Society of Detroit board of directors at it organization meeting of April 26. Among the other new officers is Kenneth R. Herman, Mem. ASME, elected as second vice-president.

Appointments. E. A. Allcut, Mem. ASME, head of the department of mechanical engineering at the University of Toronto, has been appointed as a member of the National Design Council (Canada) for a two-year period beginning April 1, 1955.

C. Harold Berry, Fellow ASME, Gordon McKay Professor of Mechanical Engineering at Harvard University and a leader in the field of heat engineering, will become professor emeritus on Sept. 1, 1955. On the same day he will take up his duties as professor of mechanical engineering at Northeastern University, Boston, Mass.

Anton deSales Brasunas, associate professor of metallurgical engineering, University of Tennessee, has been appointed to the newly created post of director of educational activities by the American Society for Metals.

Ralph Phelps, *right,* director of the Engineering Societies Library, receives $500 first prize from George T. Hook, *center,* publisher of *Iron Age* magazine, for submitting oldest issue of the magazine to *Iron Age's* back-issue contest. Looking on is Tom Campbell, *left,* editor of *Iron Age.* The prize money will be used for furthering within the engineering profession knowledge of the needs of the Library and the services offered by it. Winning issue was dated Jan. 2, 1873. *Iron Age* is celebrating its 100th anniversary this year. Second prize of $100 was won by the Schumacher-Kelly Company, Inc., Freehold, N. J., with a June 17, 1875, issue of *Iron Age.*

Shown inspecting working model of the Lombard 12,000-ton extrusion press are, *left to right,* Donald L. Block, chairman, Youngstown (Ohio) Section, ASME; William Hagel, vice-president, United Engineering & Foundry Company; Lieut. Col. Desider A. Simcoe, Chief of the Air Force Heavy-Press Program; and Daniel L. Lombard, president, Lombard Corporation, Youngstown, Ohio. The model was displayed at a recent meeting of the Section. Col. Simcoe, as principal speaker, discussed the development of extrusion presses, both here and in Germany, from before World War II to the present time.

WILLIAM J. CARSON, Mem. ASME., consulting engineer, Hartford, Conn., has been elected a member of the Rensselaer Polytechnic Institute's board of trustees. Mr. Carson, who was graduated from R.P.I. in 1928, will serve a three-year term as an alumni trustee.

HUGH L. DRYDEN, Fellow ASME, director, National Advisory Committee for Aeronautics, was elected home secretary of the National Academy of Science for a four-year term which began July 1.

C. L. EMERSON, Mem. ASME, vice-president, Georgia Institute of Technology, retired July 1, 1955, in line with the mandatory age retirement of the University System of Georgia. He plans to resume the private practice of engineering.

MARTIN GOLAND, Mem. ASME, editor, *Applied Mechanics Reviews*, recently assumed his new duties as vice-president of Southwest Research Institute, San Antonio, Texas. He had been associate director of engineering at Midwest Research Institute in Kansas City, Mo. MAX H. THORNTON has been appointed technical director, in charge of research and development operations, at Midwest Research Institute.

Engineering Foundation Plans Research to Combat Corrosion

METALS engineers, metals scientists, chemists, and physicists are teaming up in the nation's first major assault upon one of the costly and insidious enemies to American industry—metallic corrosion.

The Corrosion Research Council of the Engineering Foundation, formed with the aid of the American Institute of Mining and Metallurgical Engineers, the Intersociety Corrosion Committee, and the Electrochemical Society, will make a determined effort to learn more about Industrial Enemy No. 1 which annually rolls up a staggering five billion or more in losses through failure and fatigue of metals in critical spots in industry.

Heading the organizing committee for the proposed Corrosion Research Council is H. H. Uhlig, chief of Massachusetts Institute of Technology's Corrosion Laboratory. Far too little is known about the basic problems of metallic corrosion, Dr. Uhlig states, because fewer than a handful of major U. S. universities are presently concerned with this study, and industry has met each specific problem as it arose, thus providing limited and sketchy knowledge for general use.

During the past decade, Dr. Uhlig continued, there has been increased attention to corrosion prevention, and much has been accomplished. But over-all losses due to corrosion remain intolerably high and there is urgent need for improved focus on the problem and for intensive, increased research activity at a high level.

Corrosion is all loss; whatever corrosion can be avoided becomes a source of gain. The high costs of corrosion to American industry make worth while any reasonable investment of time and money aimed at reducing these losses. To put its "first team" of scientists to work on the problem of corrosion, the Committee plans to enlist the financial aid of industry to the sum of $200,000.

Two vital points back up the Committee's fight against the wasteful forces of corrosion. The current need is targeted on (1) increased fundamental scientific data and (2) close cooperation among scientists in electrochemistry, physical metallurgy, solid-state physics, nuclear physics, surface chemistry and physics, reaction, and others.

Establishment of a Corrosion Research Council with members chosen from American and Canadian technical societies, together with delegates from the sponsoring industries, would follow the expected financial backing by industry.

Members of the organizing committee, in addition to Dr. Uhlig, are A. V. Astin, director, National Bureau of Standards; F. L. LaQue, vice-president and head of Development and Research Division, International Nickel Company, Inc.; W. J. Sweeney, vice-president, Esso Research and Engineering Company; R. M. Burns, former director of Bell Telephone Laboratories Chemical and Metallurgical Research Division; R. B. Mears, manager, Applied Research Laboratory, U. S. Steel Corporation; and R. M. Wick of Bethlehem Steel Company, chairman of the Intersociety Corrosion Committee.

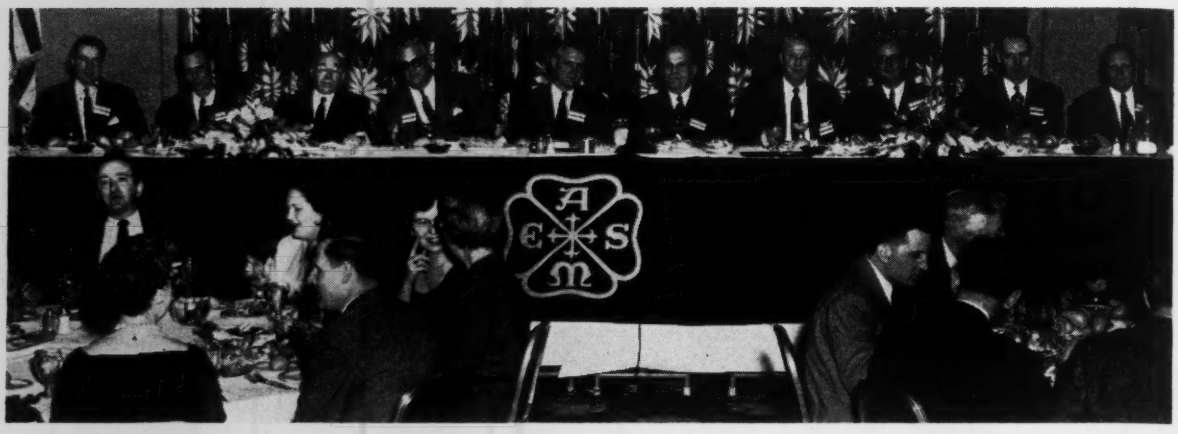
Direct contact may be made with The Engineering Foundation at 29 West 39th Street, New York 18, N. Y., or with any organizing committee member by industrial leaders willing to help defeat this troublesome and expensive industrial enemy.

ASME Publishes Nuclear-Science Glossary

WHEN is a barn not a barn? When is a doughnut (donut) not to be dunked? These terms and hundreds of others in current usage in the nuclear field are defined in "A Glossary of Terms in Nuclear Science and Technology," recently published by ASME.

The compilation of the glossary was coordinated under the direction of the National Research Council and represents the contributions of 21 technical societies and organizations.

The 189-page glossary, for the first time, incorporates all the nine sections, which originally were published separately. The glossary may be purchased from the ASME Order Department, 29 West 39th Street, New York 18, N. Y., for $5 a copy. The individual sections also are available from the ASME Order Department as follows: Section 1, Physics, $2.50; Section 2, Reactor Theory, $1.50; Section 3, Reactor Engineering, 75 cents; Section 4, Chemistry, 60 cents; Section 5, Chemical Engineering, 60 cents; Section 6, Biophysics and Radiobiology, 60 cents; Section 7, Instrumentation, $1; and Sections 8 and 9, Isotopes Separations and Metallurgy, $1.20.



Banquet Speakers. Seated at the speakers' table, *left to right*, are: C. A. Jurgensen, member of ASME Management Division Executive Committee; R. G. Hess, member, Management Executive Committee; ASME President David W. R. Morgan; Thompson Chandler, vice-president, ASME Region V; C. E. Richards, chairman, ASME Cleveland Section; L. W. Wallace, member of first management conference and past-chairman, Management Division; L. E. Newman, chairman, Management Division; H. B. Maynard, recipient of Management Division Award; T. A. Marshall, Jr., assistant secretary, ASME, and recipient of Management Division Award; C. E. Bullinger, recipient of Management Division Award.

More Engineering at Less Cost Explored During ASME Engineering Management Conference

Three ASME Members receiving the Management Division Award for outstanding contribution to engineering management. *Left to right* are David W. R. Morgan, ASME President; Louis E. Newman, chairman, Management Division, making the presentation; the three recipients, H. B. Maynard, president, Methods Engineering Council; C. E. Bullinger, professor and chairman, department of industrial engineering, The Pennsylvania State University; T. A. Marshall, Jr., assistant secretary, ASME; and L. W. Wallace, consultant, Rock Island Arsenal, member of first Management Executive Committee, and past-chairman of ASME Management Division, looking on.

More than 300 engineers gathered in Cleveland, Ohio, March 23–24, to explore new avenues and examine existing ways and means of obtaining "More Engineering at Less Cost." This theme was the motivating idea of the Third Annual ASME Engineering Management Conference, which was held at the Hotel Statler. Many problems relating to the development of managerial talent in engineers were covered in technical papers and discussion periods during the four scheduled sessions dealing with selection and training, better methods, standardization, and administration. (See June, 1955, MECHANICAL ENGINEERING, pages 540 to 542, for digests of eight of the papers. Others have been, or will be, published as features.) ASME President David W. R. Morgan was the principal speaker at the conference banquet. In his talk, "What We Can Do to Improve Engineering," he attributed the shortage of engineers to a situation in American secondary schools. While

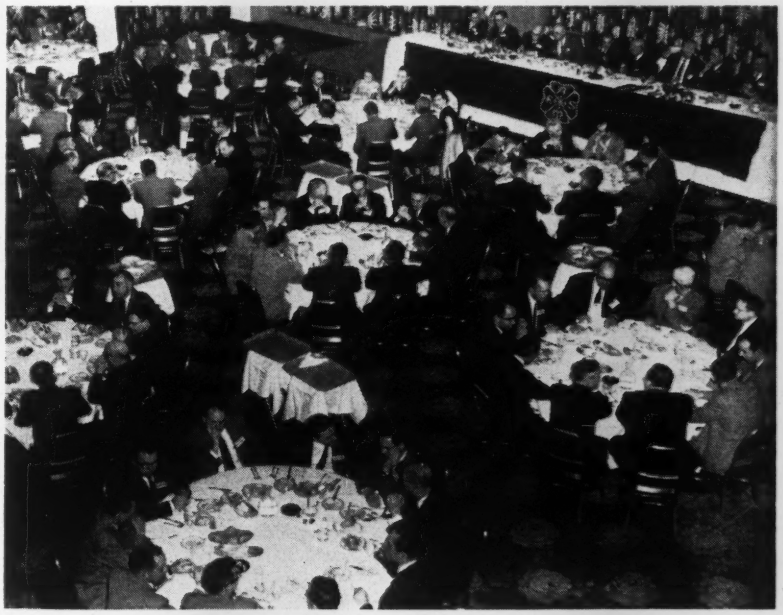
Availability List for 1955 ASME Management Conference Papers

THE PAPERS in this list are available in separate copy form until Jan. 1, 1956. Please order only by paper *number;* otherwise the order will be returned. Copies may be purchased from the ASME Order Department, 29 West 39th Street, New York 18, N. Y.; 25 cents per copy to ASME members; 50 cents to nonmembers.

Paper No.	*Title and Author*
55—MGT-1	Rigidity—The Unknown Cost-Reduction Factor, by C. A. BIERLEIN
55—MGT-2	Progressive Management and the Engineer, by J. H. ELKUS
55—MGT-3	Co-Operative Training, by C. F. ROBY
55—MGT-4	Human Relations in Industry, by LYDIA G. GIBERSON
55—MGT-5	Better Jigs and Fixtures at Less Cost, by M. J. LOOK
55—MGT-6	Streamlining Drafting Operations, by A. H. RAU
55—MGT-7	Recruiting and Training Engineering Graduates for Industry, by R. E. SPRENKLE
55—MGT-8	Get More Mileage From Your Engineers, by G. KLEIS
55—MGT-9	How Management Engineers Can Accomplish More, by V. M. GELIN
55—MGT-10	Planning Tomorrow's Engineering Budget, by C. R. SUTHERLAND
55—MGT-11	More Engineering at Less Cost Through the Use of Standard Parts, by C. AINSWORTH

Members of Industry and ASME discussing the Conference theme, "More Engineering at Less Cost." *Left to right* are: C. R. Sutherland, luncheon speaker, assistant chief engineer, Reliance Electric & Engineering Company, Cleveland, Ohio; Thompson Chandler, head, Engineering Service Division, research and development department, Carbide & Carbon Chemical Company, Union Carbide & Carbon Corp., South Charleston, W. Va., and vice-president, ASME Region V; ASME President David W. R. Morgan, vice-president, Westinghouse Electric Corp., Pittsburgh, Pa.; Warner Seely, vice-president, Warner & Swasey Company, Cleveland, Ohio; Edwin Crankshaw, chief engineer, Cleveland Graphite Bronze Company, Cleveland, Ohio; Colin Carmichael, editor; *Machine Design*, Penton Publishing Company, Cleveland, Ohio.

schools are adding facilities and increasing their teaching staffs, it is "interesting to note that a very substantial amount of facilities are devoted to extra-curricular activities." Facilities required for the teaching of mathematics, science, and physics are minimized and neglected in many cases. He cited a recent report of the Engineers Joint Council to highlight the dilemma. Of those graduated from teachers' colleges in 1954, only 264 accepted science and physics teaching posts. At the luncheon on March 23, C. R. Sutherland, Mem. ASME, assistant chief engineer, Reliance Electric & Engineering Company, Cleveland, Ohio, discussed "Planning Tomorrow's Engineering Budget." G. Brooks Earnest, president of Fenn College, spoke on "The Professional Status—Unionization Problem" at the luncheon the following day. This conference was one of the events planned for this year by the Society as part of its 75th Anniversary observance.



Over-all view of the Engineering Management Conference Banquet, March 23, held at the Hotel Statler, Cleveland, Ohio

Stanislav Spacek, famous Czech leader in management, who died in November, 1954

Stanislav Spacek, 1876–1954

L. W. Wallace Pays Tribute to Dr. Spacek

STANISLAV SPACEK, internationally famous leader in the field of management, died in November, 1954, at his home in Prague, Czechoslovakia, after a long illness.

Among his many friends in the United States, who paid tribute to his memory, Lawrence W. Wallace, Fellow ASME, consultant, Rock Island (Ill.) Arsenal, who knew Dr. Spacek for many years, had this to say:

"When I went to Washington in 1921, as Executive Secretary of American Engineering Council, Dr. Spacek was among the very first people I met, and from that time until he left the Embassy (about 1925, as I remember) there was seldom a week that we did not have a visit.

"From the beginning he manifested great eagerness to learn the methods of American management. In fact, I have known no one more eager nor more appreciative of the opportunity given him to learn of the American ways of life.

"In the early 1920's, the Czechoslovak Embassy was the spearhead for the organization of visits to the United States by numerous groups of industrialists, government officials, and students from Czechoslovakia. It was my privilege to work with both Dr. Spacek and Dr. Stepanek in arranging these tours and obtaining permission therefor from the managements of various industries throughout the United States. Dr. Spacek was always in the forefront of interest, helpfulness, and guidance for these groups. A very important aspect of this program was making arrangements with manufacturers whereby students from Czechoslovakia would spend one year or more in American plants learning methods of our management. On landing in the United States, it was invariably the custom for these student groups to come to Washington as guests of the Embassy; and the last thing before returning to Czechoslovakia, they were again guests of the Embassy. Thus 'before and after taking' so to speak, these young men came in contact with the clear vision and lovable character of Dr. Spacek.

"When we began the study of Waste in Industry, in January, 1921, Dr. Spacek followed every move with deep interest and enthusiasm. He knew intimately how the study was organized and conducted, and the results obtained. Even before the completion of the report, but after he had had some insight as to the character of the findings which would be reported, he began to discuss with me the possibility of a limited number of American engineers and industrialists visiting Czechoslovakia for the purpose of touring its industry and giving suggestions as to how management might be improved. Frank Gilbreth, about this time, had spent some time in Czechoslovakia and therefore knew of the conditions, the spirit of the people, and their eagerness to adapt some of the best American management principles to their enterprises. He therefore had many conversations with Dr. Spacek.

Steps Toward CIOS

"Dr. Stepanek also became interested, and the three of us had many conversations, finally concluding that the matter was of such great importance to many European countries other than Czechoslovakia that thought should be given to having an International Management Conference to which many European countries would be invited to send representatives. Through Drs. Stepanek and Spacek this thought was officially taken up by the Czechoslovak Government—really Dr. Masaryk, the President—and thus the First International Management Congress [in Prague, 1924, which subsequently led to the formation of CIOS] was born. It can be said that the person who, above all others, nurtured its conception and birth was Dr. Spacek. The preliminaries were pounded out at the Czechoslovak Embassy and in the office of American Engineering Council—which gave its offical approval—then other societies were brought in. What happened after that is a matter of history.

"Dr. Spacek was one of the very first to request that Waste in Industry be translated and published in the Czech language, which, of course, was authorized. Following this it was translated in part or in full in Polish, French, Italian, and German. So it can be said Dr. Spacek was the spearhead, not only in his own country, but in the improvement of management in other European countries through the translation and circulation of Waste in Industry as well as through the International Management Congress movement.

"Those of us who attended the First International Management Congress in Prague in 1924, will never forget that behind the stage, as it were, there was a motivating, devoted soul who contributed his best to making the Congress a success; and who, moreover—and probably more importantly—endeavored to bring about better understanding between the peoples of the several nations.

"Throughout these many years I had the privilege of associating with Dr. Spacek rather intimately. There was always present in him humility and a certain degree of shyness—but always a noble soul. It is my feeling that it is hardly possible to overstate a tribute to Dr. Spacek in terms of his personality, humility, devotion to the well-being of the peoples not only of his own country, but throughout Europe. The world has suffered from the tragedy of Czechoslovakia and the bridling of the souls of men such as Dr. Spacek."

Industrial-Engineering Terminology

Publication of the long-awaited ASME Standard on "Industrial Engineering Terminology" was announced during the ASME Spring Meeting by L. E. Newman, chairman of the Management Division, and manager of the Education and Training Services of the General Electric Company, New York, N. Y.

The project was begun in 1948 by the Management Division's Work Standardization Committee. In 1950 the International Committee on Scientific Management (CIOS) recognized the need for international standardization of terms by setting up a subcommittee on Management Terminology which was to limit its initial efforts to English-speaking countries.

At the Ninth International Management Congress in Brussels, Belgium, in 1951, there were further emphatic demands for standardization of terminology to end "Management's Tower of Babel," as Baron Hugo de Haan, secretary-general of CIOS, described the prevailing situation.

Spurred by these developments, the ASME Work Standardization Committee increased its output of technical definitions and organized a thorough procedure for their verification. Definitions were drawn up by an industrial-engineering expert and submitted for suggestions to 40 practicing management consultants, to an equal number of committee associates, and finally to the terminology committee of Australia, Canada, South Africa, and Great Britain.

Prof. C. E. Bullinger, head of the industrial-engineering department at the Pennsylvania State University, and vice-chairman of the Work Standardization Committee, reviewed and co-ordinated the suggestions from all sources prior to final approval by the ASME Board on Codes and Standards. H. B. Maynard, president of Methods Engineering Council, Pittsburgh, Pa., is chairman of the committee and T. A. Marshall, Jr., is vice-chairman for international co-ordination. Other members of the committee are R. M. Barnes, C. B. Gordy, P. E. Holden, J. K. Louden, and D. B. Porter.

Result of these painstaking efforts is a handy 50-page compendium of 500 industrial-negineering terms arranged in alphabetical order and running from the initial entry, "abnormal

reading," through "written standard practice." Definitions are as brief as practicable and can be understood even by nonexperts in the field.

Subjects range from elementary definitions, such as those for industrial engineering or for a standard itself, to an entire series of complex production terms. There are concise descriptions of the flow-process chart and the Simo chart, of the Gantt chart as well as the Gantt task and bonus plan, of job classification and evaluation, of process layout and work station.

Various instruments such as the marstochron and the kymograph are also included. "Therblig," a term coined by Frank B. Gilbreth to designate subdivisions of work in his classification of physical motions and associated mental processes, is defined as follows: "The name of the basic work elements which are used in varying sequence and combinations to perform all manual and/or mental work."

"Industrial Engineering Terminology" fills an important place in the well-known series of ASME Codes and Standards for safe construction, operation, and testing of elevators, boilers, piping, and screw threads. Copies of the book are available from the Order Department, The American Society of Mechanical Engineers, 29 W. 39th Street, New York 18, N. Y., at $1.50 each.

ASME "Portable" Library

America's largest portable engineering library set up shop in the Lord Baltimore Hotel when The American Society of Mechanical Engineers opened its Spring Meeting in Baltimore, Md.

Hundreds of engineers, businessmen, contractors, and technical educators flocked to the library, where their interest in one or more of the 225 technical books, periodicals, bibliographies, reference works, safety codes, standards, power test codes, and miscellaneous pamphlets were available at prices ranging from 50 cents to $25.

The $25 applies to ASME's best-selling Boiler and Pressure Vessel Code, a 900-page tome that represents one of the society's outstanding contributions to industrial and maritime safety.

Latest major addition to the library is the 176-page American Standard National Plumbing Code, which was recently approved and published after 20 years of work. Its price is $3.50.

ASME's Publications Department does a $300,000-a-year business in books alone. Its output covers such subjects as applied mechanics, heat transfer, hydraulics, fluid meters, diesel engines, metals, management, gas and reheat turbines, machine-tool design, plumbing fittings and systems, and "bolts, nuts, rivets, screws, and similar fasteners."

Not all the publications are technical. "Partners for Life" told the story of Frank and Lillian Gilbreth long before "Cheaper by the Dozen" saw print. One of seven biographies published by ASME, it tells the story of two of the Society's best-known members.

Predicated on the success of the portable library at the Spring Meeting held in Baltimore, Md., the library was once again set up at the Hotel Statler in Boston, Mass., during the ASME Diamond Jubilee Semi-Annual Meeting, June 19–23.

As in the past the hundreds of member engineers and their guests, who attended the technical sessions and social events, flocked to the library to examine the latest Society publications.

Careers for the Mechanical Engineer

Intended, among a number of purposes, to interest prospective engineering students, a 44-page book, "Careers for the Mechanical Engineer," has just been issued. It is the first of a series on various branches of the engineering profession.

Several major companies have presented in the new publication a symposium indicating opportunities for mechanical engineers in diverse fields of industry. Two pages are devoted to an article, "Planning Your Future," by T. A. Marshall, Jr., assistant secretary, ASME, and former secretary of Engineers Joint Council.

"To the best of our knowledge, this is the first time that company information has been angled to a single category within the profession," says the publisher, Career Publications, Inc., 14 West 45th Street, New York 36, N. Y.

Copies have gone without cost to about 7000 Seniors and Juniors in mechanical engineering in 130 schools, to college-placement offices, and to concentrations of engineers in the Armed Forces.

Single copies may be obtained from the publisher at $1, plus 25 cents for handling. Discounts are given on orders in numbers of copies.

Atomic-Energy Section to Be Featured at Chicago Power Exposition

An atomic-power section will be a feature of the Chicago Exposition of Power and Mechanical Engineering at the Chicago Coliseum, November 14 to 18. The exposition will be held under the auspices of The American Society of Mechanical Engineers, whose Nuclear Engineering Division will provide a program of technical papers in the field of atomic power for the Society's concurrent meeting. Exhibits in the atomic-power section will disclose phases of the application of atomic energy to power of special interest to mechanical engineers.

The ASME has sponsored the Exposition of Power and Mechanical Engineering for many years, usually in the biennial even-numbered years. This year's special Power Show was planned as part of the Diamond Jubilee Annual Meeting in Chicago, climaxing the year-long celebration of the Society's 75th year.

The exposition is under the management of the International Exposition Company, 480 Lexington Avenue, New York. E. K. Stevens is the exposition manager.

Actions of the ASME Executive Committee

At a Meeting at Headquarters, May 25, 1955

A Meeting of the Executive Committee of the Council was held on May 25, 1955, in the rooms of the Society. David W. R. Morgan, chairman, presided. In addition to Mr. Morgan there were present: Frank L. Bradley, Thompson Chandler, and W. F. Thompson of the Executive Committee; Joseph L. Kopf, treasurer; E. J. Kates, assistant treasurer; L. N. Rowley, Jr., chairman, Finance Committee; J. W. Barker, chairman, Organization Committee; William H. Byrne, vice-president; R. B. Lea, H. C. R. Carlson, and Joseph Pope, directors; C. E. Davies, secretary; O. B. Schier, 2nd, T. A. Marshall, Jr., D. C. A. Bosworth, assistant secretaries; and Paul R. Sidler, chairman, Professional Divisions' Budget Committee.

Boiler and Pressure Vessel Committee

The Executive Committee approved a statement of policy on use of code symbols in advertising for the marking of boilers, pressure vessels, and certain appurtenances which have been constructed and inspected in compliance with the ASME Boiler and Pressure Vessel Code. The statement is to be included in the body of the published Codes and sent to all Code Symbo. Stamp Holders.

Participation in Meetings of Other Organizations

A Policy on Co-Sponsorship, Co-Operation, or Participation by ASME in conferences arranged and conducted by other organizations was approved for two years. Approval was given with the understanding that expenditures incurred under the Policy will be within the budget limits for ASME meetings and Professional Divisions' operation.

Publications Policies

As part of the long-range program to deal with the increased volume of Society papers, the Publications Committee has had a special committee studying possible modifications in the present publications procedure. A comprehensive report was submitted to the Board on Technology on May 23 which pointed out that time would not permit detailed recommendations with respect to all aspects of pub-

lication policy and that certain major policies should be the subject of continuing study. In the meantime, it was recommended that the present pricing and distribution policies for Transactions, the *Journal of Applied Mechanics*, and preprints be continued, including the policy of sending each member ten free preprint coupons.

The Executive Committee authorized continuation for the present of these pricing and distribution policies.

1956 National Meetings

It was noted the following National Meetings were authorized for 1956: Spring Meeting, Portland, Ore., March 18–21, Multnomah Hotel; Joint ASME-EIC Meeting, Montreal, Que., Can., May 23–25; Semi-Annual Meeting, Cleveland, Ohio, June 17–21, Hotel Statler; Annual Meeting, New York, N. Y., Nov. 25–30, Hotel Statler.

Film on Mechanical Engineering

Mr. Marshall reported that the script of the proposed motion picture on mechanical engineering had been approved by the 75th Anniversary Committee. Photography will be started the second week in June and early in July a working film will be completed for review by society representatives. It is hoped to have the finished film ready to show at the Program Makers' Conference on July 29.

A suggestion was made that the film might be useful to industry and Mr. Marshall was asked to recommend prices for such sales.

Resolution of Thanks

It was voted to discontinue the adoption of the Resolution of Thanks at National Meetings of the Society and to establish as a continuing Society policy that the conveying of appreciation and thanks of the Society to all those who participated in such meetings be the responsibility of the President and the Secretary.

Section-Boundary Changes

The following changes were authorized in Section boundaries: Counties of McDowell, Yancey, Mitchell, and Avery to be included in the Greenville, S. C., Section; counties of Rutherford, Kershaw, Darlington, Marlboro, and Fairfield to remain in the Piedmont-Carolina Section.

Student Branches

The following advice from John A. McPherson, Jr., chairman, Region IV Student Branch Committee, was noted: That it was agreed at the time of the allocation of counties from Atlanta, Savannah, Piedmont-Carolina, and Greenville Sections to the Central Savannah River Area that the University of South Carolina Student Branch would be assigned to the CSRA Section and the Student Branch at Clemson Agricultural College would remain in the Greenville Section.

It was reported that the Toledo Section had taken over the Ohio Northern University Branch.

Student Contest

Vice-President Thompson presented the suggestion from Region I that the winners of the Regional Student Branch Conference Prizes be brought together at a national occasion for the selection of a national prize winner. The vice-presidents were requested to review the suggestion and present their recommendations.

Certificates of Award

Certificates of Award were granted to the following retiring chairmen of Professional Divisions' Executive Committees: John A. Worthington, Oil and Gas Power; and J. F. Lederer, Safety.

The following retiring chairmen of Sections were granted Certificates of Award: R. L. Holloway, Jr., Canton-Alliance-Massillon; M. E. Kirkpatrick, Central Savannah River Area; W. L. Hartman, Columbus; and A. H. Duncan, Kansas City.

Certificates were also granted to the following retiring chairmen and representatives of Region III Committees: M. E. Silberger, Sections Committee; William E. Reaser, Student Branch Committee; A. W. Weber, Membership Development Committee; E. R. Birkicht, Civic Affairs Committee; W. N. Richards, Advisory Member, Publications Committee; J. W. Putt, National Membership Development Committee, representative; and F. C. Evans, National Civic Affairs Committee, representative.

Arthur Gompf, chairman of the Baltimore Spring Meeting, April 18–22, 1955, and Ernest H. Hanhart and Louis E. Carter, co-chairmen, were granted certificates.

Ray Hanson, chairman of the Detroit Section, 1949–1950, was granted a certificate.

Gift to Society

The President reported that Mrs. Walter C. Baker of Cleveland, Ohio, the widow of an ASME Member, had presented a gift of money to the Society. The Secretary was asked to express appreciation and thanks to Mrs. Baker.

Elmer A. Sperry Board of Award

Revised rules of award adopted by the Elmer A. Sperry Board of Award at its May 18, 1955, meeting were approved.

ASME-EIC Initiation Fees

The ASME-EIC International Council has agreed on a plan for reciprocal initiation fees with the Engineering Institute of Canada similar to that in effect with the American Institute of Electrical Engineers. This will be presented to the Council at its meeting in Boston, Mass., for consideration.

Conference in Canada

At a meeting of the ASME-EIC International Council held in Toronto, Ont., Can., May 13, the Potsdam Conference on "Trends in Mechanical-Engineering Education" was discussed. It was suggested that a similar conference be held in Canada at the University of Western Ontario, London, Can., in October, 1956.

The Executive Committee voted to approve such a conference to be held in Canada in the fall of 1956.

75th Anniversary Award

Vice-President Chandler reported that he represented President Morgan at the annual dinner of the Engineering Institute of Canada and presented the special 75th Anniversary Award to Colonel L. F. Grant, president, Engineers' Council for Professional Development.

New Engineering Societies Building

Attention was called to the action of the American Institute of Chemical Engineers regarding the proposed new engineering building at its meeting on May 2, 1955. The AIChE Council indicated a definite interest in the proposed Engineering Center in Schenley Park, Pittsburgh, Pa., although it is not prepared to commit itself at this time.

James Watt International Medal

The Secretary reported that the 1955 James Watt International Medal was conferred upon Igor I. Sikorsky, nominated by ASME, at a meeting of The Institution of Mechanical Engineers in London, England, April 29, 1955.

Appointments

The following appointments on committees and joint activities were approved:

Daniel B. Worth, Air Pollution Controls Committee;

Charles A. Jurgensen, Research Committee on Engineering Administration;

David W. R. Morgan, John Fritz Medal Board of Award, four-year term;

Arthur M. G. Moody, Washington Award Commission, two-year term;

William H. Thompson, ASA Sectional Committee on Recommended Practice for Mechanical Refrigeration Installations on Shipboard, B59;

Robert Matters, A. W. Rankin, and H. A. Wagner, Joint ASME-ASTM Committee on Effect of Temperature on the Properties of Metals.

Presidential Appointments

The following presidential appointments were noted:

Joseph Pope to Wallace Clark Award Luncheon for Col. Lyndall F. Urwick, May 24, 1955;

R. E. Peterson to Stockholm Conference on Fatigue, May 25, 1955;

Mervin B. Hogan, Inauguration of President and Annual Commencement, Utah State Agricultural College, Logan, Utah, June 3–4, 1955.

Junior Forum . . .

Conducted by R. A. Cederberg,[1] Assoc. Mem. ASME

The Young Mechanical Engineer in Sales

By Cortland A. Bassett[2]

SELLING is a profession which depends on a number of basic requirements, and whether your product is a drill press, a pair of trousers, a box of doughnuts, a Yo-Yo, an idea, or just yourself, your success in selling depends on the same general factors.

In selling, many things are assumed, such as product knowledge, integrity, loyalty, neatness, and a degree of personality. I do not wish to infer that these points are not of major importance because they are, but they are either self-developed or the result of hard work and are therefore within the reach of all individuals who desire them.

The points that I do wish to emphasize are characteristics which depend on a certain intangible something inside you over which, to a large degree, you have no control. There are five major phases which come to mind. As a mechanical engineer, taking up a life's work *connected with the sales field*, you must have these qualifications if you are to succeed.

1 *You must love your job—not like it!* I was graduated from college with a degree in chemistry, spent five years in the Army in a field connected with public relations, and came out looking for a position. Deep in my heart I felt that I could not be happy again working over a foaming test tube. I, therefore, decided to look for a position in sales.

Although it meant learning the fundamentals of a completely new field, I joined the company which I represent today (The L. S. Starrett Company of Athol, Mass.). I completed the apprentice course which showed me how to manufacture and use the tools which I must learn to sell. To a large extent, the very people who gave me my technical training also helped me extensively in my sales training as my relationships with executives, administrative personnel, foremen, and fellow workmen gave me an opportunity to "get along" with the types of people that I would later depend on for my success or failure. *I love the job*, and if I didn't, I would change my field. For when you consider that more than one half of your awake hours are spent working at it or thinking about it, it becomes apparent that you must be thoroughly happy in the field that you choose.

2 *You must service your customer to death!* This is a figurative statement which applies to any line of endeavor an individual may be in. The student in mechanical engineering must have an inherent desire to do a better job on his drawings than he believes the instructor is going to expect from him. The desire to do the minimum necessary to get by is not enough. The customer in this case is the instructor.

The mechanical engineer himself must have this same desire to more than completely satisfy his superintendent in each job that is assigned to him, and the design engineer must be a true salesman, for he must continuously consider his customer's necessities and desires, or the tools that he designs will not sell to that same customer.

The mechanical engineer in sales likewise will find that servicing his customer to death will be one of his major selling weapons against competition, because, in the final analysis, the man with the most good answers to the customers' problems is the one who is going to receive the order.

3 *Be Yourself!* There is frequently something within the individual that makes him profess to be something that he isn't or to know something that he doesn't. I quote in part from a leading sports publication regarding the play of the winning golfer on a crucial hole of the Master's Tournament. "His eagle, because of how it happened, will undoubtedly be referred to as long as golf is played. Eight thousand persons may have been lucky enough to have witnessed it but the count will certainly rise from year to year." Why people do this is an intangible, but they do. The case of Douglas Stringfellow and his imaginary war exploits is another recent example.

Many workers applying for a job in metalworking are asked if they can read a micrometer. Many who do not have the slightest knowledge of using one claim they are familiar with it and are still looking for a job because the interviewer produces a micrometer and asks them to interpret a set reading.

One of the biggest mistakes among salesmen occurs in the simple diversion of telling jokes. The recognized trade-mark of a salesman has always been his joke-telling ability, and so many try so hard and so futilely. Very few people (including salesmen) are imbued with the talent and timing for telling jokes and yet so many try, with the resulting "clink." Be Yourself! Do those things which you do best and eliminate those which you do worst. Improve on those which you do moderately well and you have one point of a good salesman.

4 *Make decisions confidently!* Many people will do almost anything rather than say "yes" or "no." Inwardly, they just don't feel like making a decision. They would much rather answer "Perhaps" or "Maybe" or "I'll see." In sales you are working alone and many of your decisions must be your own. Confident salesmen usually become confident sales executives and frequently confident company presidents.

5 *Like people!* Some people like only those people who show a liking for them and will make friends only if you make the first move. They are reserved in their opinions of people and wait for the person to prove himself before warming to that person. The good salesman makes the first move, is immediately friendly, and waits for an individual to prove himself bad before even assuming the possibility. It is merely a matter of positive rather than negative thinking. If you don't like people, don't go into sales.

I would like to again mention the assumed requirements. Product knowledge is most important. It not only makes you confident, but it imparts confidence to the customer. As an example, if I were to go into an account and a bandsaw machine operator were to tell me that he was cutting aluminum on a certain name-brand bandsaw machine, I would remark immediately, "Oh yes, I think you will find that machine takes a 10-ft band and I would recommend a $\frac{1}{2}$-in-wide skiptooth blade run at 1500 ft per minute." That indication of product knowledge would impart confidence to him.

Integrity and loyalty need no explanation. But don't be afraid to say, "I don't know, but I'll find out." Too many times, because we feel we should know an answer, we try to fool ourselves and our customer into believing we know. This is a weak sales policy. Neatness in yourself and in your work are obvious requisites for a good salesman.

Personality cannot be judged by the old standards of the "dynamic salesman" but is based today on the development of the best points of an individual.

In conclusion, the young mechanical engineer who knows his business well, likes the people he works with, and feels confident of his ability to make decisions has a good chance of succeeding in sales. The chances are that this man won't like his job—he'll love it—and as a result will have an excellent chance of reaching the top in salesmanship!

[1] Westinghouse Electric Corp., Radio-Television Division, Metuchen, N. J.

[2] Sales Engineer, L. S. Starrett Company, Athol, Mass.

. . . Chairman's Corner[3]

Nuclear Engineering Division—Did you read about the formation of a Nuclear Engineering Division in the May issue of MECHANICAL ENGINEERING? Two Associate Members were appointed as Junior Advisers and each committee (of the Division) was authorized one Junior Adviser. If any of you are interested in the work of this division you can really get in on the ground floor by dropping a line to the Chairman, A. C. Pasini, Detroit Edison Company, 2000 Second Avenue, Detroit 26, Mich.

Gas Turbine Division—Along the same line there is still room for a couple of good men in the Gas Turbine Division. If you're interested let me know and I'll pass the word along.

Board on Education and Professional Status—One of my functions as chairman of the Junior Committee is to be a member of the

[3] Charles T. Miller, Chairman, National Junior Committee, 45 River Drive, Passaic, N. J. Assoc. Mem. ASME.

Board on Education and Professional Status. One of the reasons I have this function is so I may pass along any problems that you Associate Members may have which fall within the scope of this committee. A case in point is that of an Associate Member who lives in Ohio, but is desirous of getting registered in New York. The drawback is the requirement of the New York Registration group that Associate X is to provide several names of engineers registered in New York for recommendation. We do not have a solution to this problem as yet but hope to have it in time for the next edition. This is but one way that we can help you. If you have a matter which is of concern to you, we would like to hear about it.

NSF Funds for Refrigeration Congress

THE National Science Foundation has decided to provide financial assistance for a limited number of engineers and scientists to attend the Ninth International Refrigeration Congress to be held at Paris, France, from Aug. 31 to Sept. 8, 1955. Application forms for these travel grants may be obtained from the National Science Foundation, Washington 25, D. C. The closing date is July 15, 1955.

Society for Visiting Scientists Established in London, England

THE Society for Visiting Scientists, 5 Old Burlington Street, London, W.1., was established in the spring of 1944. The society seeks to be a focus for all scientists visiting the United Kingdom and to put them in touch with British scientists and with one another. The society aims to provide and encourage an active exchange of scientific thought and discussion between scientists of the UK and scientists from overseas.

The House of the society provides many accommodations among which is included some residential accommodation. In addition, an information service is provided which is open to all members. Any scientist arriving in England can, if he wishes, proceed at once to the House and be given such advice and information as is available and details of how he may apply for membership. A number of receptions have been held in honor of groups of allied scientists visiting Britain, who have had an opportunity of meeting at the House their British and overseas colleagues.

One of the most stimulating of the society's activities has been the holding of discussion meetings on subjects of general interest to scientists.

The society's Council includes among its members scientific representatives of several countries, as well as many distinguished British scientists. The president and chairman is Prof. A. V. Hill.

Engineering Societies Personnel Service, Inc.

THESE items are from information furnished by the Engineering Societies Personnel Service, Inc., in co-operation with the national societies of Civil, Electrical, Mechanical, and Mining and Metallurgical Engineers. This Service is available to all engineers, members, or nonmembers and is operated on a nonprofit basis.

In applying for positions advertised by the Service, the applicant agrees, if actually placed in a position through the Service as a result of an advertisement, to pay a placement fee in accordance with the rates as listed by the Service. These rates have been established in order to maintain an efficient nonprofit personnel service and are available upon request. This also applies to registrant members whose availability notices appear in these columns. Apply by letter, addressed to the key number indicated, and mail to the New York office.

When making application for a position include six cents in stamps for forwarding application to the employer and for returning when necessary. A weekly bulletin of engineering positions open is available at a subscription of $3.50 per quarter or $12 per annum for members, $4.50 per quarter for nonmembers, payable in advance.

New York	Chicago	Detroit	San Francisco
8 West 40th St.	84 East Randolph St.	100 Farnsworth Ave.	57 Post St.

Men Available[1]

Mechanical Engineer, PhD, interested in applied mechanics and experimental stress analysis. Desires a research or teaching position. Me-229.

Industrial Engineer, 26; BME; three years' experience in plant layout, methods, procedures; including organization and direction of plant-layout program for well-known manufacturer. Desires position with broader responsibilities. Prefers Northeast. Me-230.

Mechanical-Electrical Engineer, 44; 21 years' experience in operation, construction, and design of utility-steam-generating stations. Me-231-245-Chicago.

Mechanical Engineer, 28; BSME; two years' experience co-ordinating expansion of turbine-laboratory facilities, specification and report writing; three years' experience as supervisor drop-forge; one and a half years' experience in manufacture power-plant equipment. Desires domestic or foreign employment. Me-232.

Industrial Engineer, 30, married; ME; seven years' machine-shop and methods-engineering background; cost reduction, analysis of production costs, plant layout. Four credits required for MS (IE). Desires position analyzing business operations. Me-233.

Mechanical-Industrial Engineer, desires position in management, consulting, or small-plant metalworking industry. Four years project engineer in aircraft-engine development; four years sales and contract engineer in heating, air-conditioning industries; BAE, MME, PE in N. Y. and N. J. Completing work toward doctorate in industrial and management engineering. Willing to travel, but desires N. Y. metropolitan area. Me-234.

Production Engineer, 27, single, BSME; one year heavy-machine tooling, processing, plant layout in ordnance work; one year contact engineering automotive-assembly plants, improving tooling, methods, and quality; two years' automotive press-shop supervisor, heavy automation program, tooling, production planning. Desires production-engineering or technical sales position. Me-235.

[1] All men listed hold some form of ASME membership.

Positions Available

Instructor or Assistant Professor, MSME, to teach heat subjects and normal mechanical-engineering laboratories. Should be active in technical and professional organizations. Salary and academic rank open. Position starts September, 1955. Midwest. W-1169.

Design Engineer, mechanical graduate, at least ten years' supervisory experience covering design and layout of air-conditioning systems in commercial, industrial, and process buildings. $8000–$10,000. Eastern Pa. W-530.

Engineers. (*a*) Assistant works manager, 28–38, graduate mechanical, several years' experience in all phases of engineering control over tooling and processes; analysis of production problems; trouble shooting on high-volume continuous-production equipment, etc. Practical experience in machine-shop practice and tooling essential; knowledge of basic machine design, as applied to special automatic machinery desirable. Midwest. (*b*) Mechanical development engineer, 28–38, graduate mechanical, with a leaning toward electrical engineering. Should have a minimum of four years' experience in creating and building special-purpose high-speed automatic or semiautomatic machinery, preferably in the soft-goods or consumer-goods machinery field. Conn. W-1542.

Design Engineer, eight to ten years' experience in the design of steam-power-plant equipment, boiler auxiliaries. Should have power-plant experience or at least know about power-plant requirements. Will work closely with manufacturing and research department. Position will lead to that of chief engineer so should have administrative ability. Salary open. Pa. W-1550.

Instructor, master's degree in mechanical engineering or naval architecture and marine engineering, with some teaching experience. Will teach strength of materials and machine design or elementary naval architecture and propeller design. $4800, to start, for ten-month academic year. N. Y. metropolitan area. W-1562.

Chief Engineer, 35–50, graduate, capable of heading up operating division, for a manufacturer of hydraulic equipment. To $20,000. East. W-1566.

Junior Engineers, mechanical or civil, for drafting office and field engineering covering gasoline stations and bulk terminals. $4800–$5400. N. Y. metropolitan area. W-1569(*b*).

Industrial Engineers, graduate mechanical or industrial, 25–35, at least two years' industrial-engineering experience, to assist any and all departments and divisions by recommending changes that will achieve better and cheaper operations, for manufacturer of sensitive tapes. About $6000. N. J. W-1573.

Manager, engineering division, graduate mechanical, up to 50, at least ten years' experience in administrative work, to act as administrative chief engineer of a department of 30 people. Will supervise research development and design; follow projects through to production for a manufacturer of dairy equipment. $11,000, or more depending on experience. Employer will pay fee. N. Y. State. W-1590.

Teaching Personnel. (*a*) Instructor, for mechanical-engineering department, to teach engineering drawing and descriptive geometry. (*b*) Instructor or assistant or associate professor, to teach undergraduate and graduate work in mechanical engineering. (*c*) Instructor, in mechanical engineering, to teach in the field of metal processing, which may be combined with either engineering drawing or mechanical-engineering

(*ASME News continued on page 654*)

which impulse for you?

STANDARD STEAM TRAP

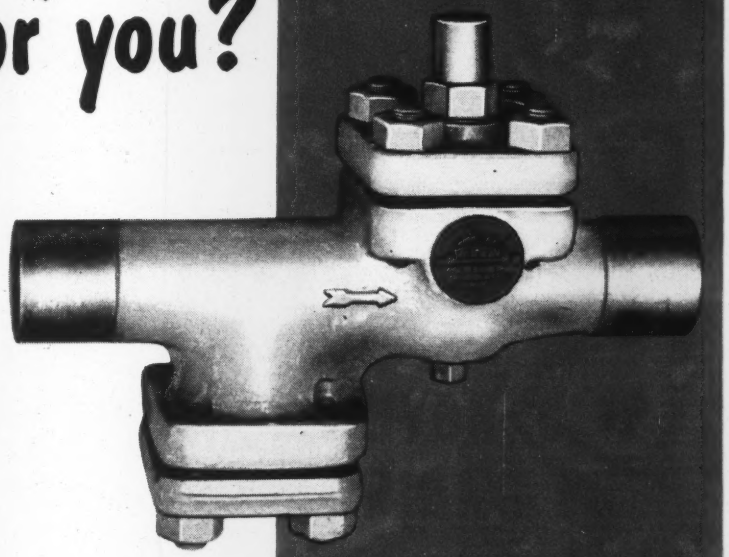
The standard YARWAY Impulse Steam Trap serves all normal trapping requirements. Factory set to operate without adjustment at all pressures from 20 psi to 400 psi (Series 60) and 600 psi (Series 120). For pressures below 20 psi, merely remove split washer.

Numerous advantages like:

small size
quick heating
steady temperatures
stainless steel construction
one moving part
non-freezing
low cost

More than 900,000 used throughout industry.

Write for YARWAY Bulletin T-1740.



HIGH PRESSURE, INTEGRAL-STRAINER STEAM TRAP

YARWAY Integral Strainer High Pressure Impulse Steam Traps operate on some of the highest pressure steam lines in the country. Same operating principle as the standard YARWAY Impulse Trap. Strainer built into trap.

Ample capacity when system is being "warmed up"—yet will handle relatively small amounts of high temperature condensate without losing prime. Six sizes—½" to 2". Pressures to 1500 psi (flanged ends) or 2500 psi (welding ends).

Write for YARWAY Bulletin T-1740.

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laboratory. Instructor, $4020–$5820; assistant professor, $5160–$7560; associate professor, $5760–$8760; professor, $6540–$10,740 a year. New England. W-1593.

Chief Engineer, not over 50, good administrator; some experience in installation and engineering of heavy equipment in the basic steel industry. Knowledge of forging, casting, etc.; familiar with combustion. Company will pay placement fee. $12,000–$15,000. Western Pa. W-1596.

Superintendent of buildings and grounds, mechanical graduate, at least ten years' experience, three or four years of which were supervisory. Must be familiar with all trades and skills. $10-000–$12,000 Long Island, N. Y. W-1600.

Packaging Engineer, mechanical or industrial graduate, manufacturing and packaging experience covering building materials or household products. $6600. Newark, N. J., area. W-1601.

Chief Industrial Engineer, up to 50, at least five years' experience in supervising engineering department on heavy mechanical equipment. Must be good administrator; have good knowledge of combustion and mechanical engineering. Will supervise engineering department consisting of project, combustion, electrical, mechanical, and product engineers on heavy industrial equipment. $15,000. Pa. C-3086.

Insurance Technical Adviser, mechanical, up to 45, at least three years' experience in research or production of electromechanical equipment; installation experience useful. Knowledge of electromechanical equipment in general. Will do inspection of insurance risks, appraisal, and adjustments on a broad type of electromechanical equipment, for insurance company. $6000–$9000. Some traveling. Chicago, Ill. C-3089.

Project Engineer, mechanical or electrical, at least two years' experience in small-product design or development such as small maintenance tools, to develop and design new products, redesign old products; some field work with customers. $5400–$7800. Employer will negotiate fee. Ill. C-3095.

Project Engineer, mechanical, to 45, at least three years' experience in project work on fast-moving machinery such as packaging, printing, or paper-folding equipment; knowledge of printing helpful. Will do project work in design, maintenance, and installation of very fast-moving light-automatic machinery. Up to $10,000. Employer will negotiate fee. Ill. C-3179.

Instrumentation Superintendent, process plant graduate, to 45, experienced in instrument systems and control for chemical-process plant; able to develop methods; apply commercial instruments; modify existing or new equipment; supervise hourly electric and instrument and maintenance men in repair shops, plant, and engineering department. Responsible for all instrument work, planning, service, operation, maintenance, and repair. $9000. San Francisco Bay area. S-119.

Candidates for Membership and Transfer in the ASME

The application of each of the candidates listed below is to be voted on after July 25, 1955, provided no objection thereto is made before that date and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications

For Member, Associate Member, or Affiliate

AMBLARD, MARCEL E., Charleston, W. Va.
ANDERSEN, VAN STERNER, Park Forest, Ill.
ANDERSON, CARL H., Bridgeport, Conn.
ARMSTRONG, ASA W., Arlington, Va.
ARO, ANTS, Akron, Ohio
ARYANPOUR, HOUSHANG, Teheran, Iran
ASHTON, ALBERT A., Houston, Texas
BACON, THOMAS S., Dallas, Texas
BALLY, GERARD, Mexico, D. F., Mex.
BENSON, JAMES W. L., Elkin, N. C.
BERGEN, HAROLD A., St. Joseph, Mich.
BERGIN, ROBERT F., Dearborn, Mich.
BERLIEN, DOYNE B., Charleston, W. Va.
BISHOP, JOHN G., JR., Fairhope, Ala.
BOYD, DAVID E., Cuba, N. Y.
BRANSTROM, FRANK O., South Euclid, Ohio
BROCKMAN, FREDERICK W., Baltimore, Md.
BROWN, E. WILLIAM, Newnan, Ga.
BROWN, JAMES T., Albuquerque, N. Mex.
BUFFLAP, CARL A., JR., Philadelphia, Pa.
BULK, GEORGE K., Los Angeles, Calif.
CARLSON, HAROLD A., Schenectady, N. Y.
CARROLL, PAUL F., Glenview, Ill.
CHERRY, HAROLD, Erie, Pa.
CHITTENDEN, WILLIAM A., Chicago, Ill.
COBB, ALLAN E., Burbank, Calif.
COBB, CLYDE E., Burbank, Calif.
COHEN, LEWIS, Richmond Hill, N. Y.
COURSEY, EDWARD G., Augusta, Ga.
COWHER, JACK L., Towanda, Pa.
COX, JOHN F., JR., Passaic, N. J.
DABORA, ELIAHOU K., Trenton, N. J.
DAVIDSON, EUGENE S., Brooklyn, N. Y.
DAY, EN-CHAO, Taiwan, Formosa
DAY, ROBERT W., Amherst, Mass.
DOBBIN, ROSS L., Peterborough, Ont., Can.
DOCKERY, JERRY C., South Pasadena, Calif.
DONNELLY, CYRIL F., Charleston, W. Va.
EVANS, TED C., Wellsville, N. Y.
EVANS, WILLIAM B., Huntington Park, Calif.
FELBECK, DAVID K., Washington, D. C.
FERNANDEZ, JOSE F., Fort Worth, Texas
FISHER, FRANKLIN G., Reading, Pa.
FLETCHER, C. NORMAN, Cheshire, England
FOSTER, ARCH L., Dallas, Texas
FOWDEN, WILBUR M. M., JR., Annadale, Va.
FRANK, EARL E., Kenmore, N. Y.
FREDERICK, EDMUND, Mt. Vernon, Ohio
FREEDMAN, JEFFREY C., Brooklyn, N. Y.
GALLAGHER, JOHN J., Irvington, N. J.
GAMBERTON, JAMES H., New York, N. Y.
GEREN, LORENZO D., Lake Jackson, Texas
GLADDING, JAMES N., JR., Mobile, Ala.
GRANT, DONALD C., Orange, Calif.
GRANTZ, HOWARD E., Schenectady, N. Y.
GUIDERO, ALFRED L., La Canada, Calif.
HASLAM, WILFORD L., Los Angeles, Calif.
HEALD, BENJAMIN C., JR., Dallas, Texas
HERNANDEZ, H. PAUL, San Francisco, Calif.
HIRSCHBERGER, CARL R., Brooklyn, N. Y.
HOLLIDAY, IVAR M., Los Angeles, Calif.
HORN, EDWARD P., Wellsville, N. Y.
JANNETT, FRED J., Roselle Park, N. J.
JOHNSON, G. LAWTON, Lyme, N. H.
KARR, CHARLES L., JR., Oslo, Norway
KINNEY, ROBERT C., Lake Jackson, Texas
KNIPPENBERG, HENRY W., Hartsdale, N. Y.
KOBARA, TOWRU, Tiffin, Ohio
KRAMER, FRED A., JR., Clayton, Mo.
KRAUTER, DONALD W., Scotia, N. Y.
KUBLER, FRANK M., Pensacola, Fla.
LAIRD, HUBERT C., Chicago, Ill.
LANNING, HAROLD K., Topeka, Kansas
LAROBARDIER, LAMONT M., Closter, N. J.
LEECH, JOSEPH A., Chicago, Ill.
LEHNERT, JOHN, Massillon, Ohio
LEONARZ, EMIL A., Mexico, D. F., Mex.
LITMAN, JAMES, Los Angeles, Calif.
LOEB, CARL M., JR., New York, N. Y.
LOUNDON, DAVID A., Evreux (Eure), France
LYNCH, JOHN K., Levittown, N. Y.
MALLETT, HORACE G., Schenectady, N. Y.
MANOGG, CHARLES D., New Milford, N. J.
MARINO, DANIEL, JR., Boyaca, Colombia, S. A.
MARTINY, WALTER, J., JR., Schenectady, N. Y.
MASSELL, CHARLES B., Toronto, Ont., Can.
MAYNARD, EDWIN P., JR., Lake Jackson, Texas
MCCLINTOCK, ROBERT, Brooklyn, N. Y.
MCDONALD, DANIEL J., JR., Philadelphia, Pa.
MCFALLS, DAVID L., Cliffside, N. C.
MCLANE, DANIEL J., JR., Schenectady, N. Y.
MENIRU, GODWIN U., Toledo, Ohio
MEYER, RAYMOND, Massillon, Ohio
MILLER, DANIEL R., Schenectady, N. Y.
MONTEATH, GORDON G., Ottawa, Ont., Can.
MORHART, RONALD F., Union, N. J.
NEUHART, DAVID S., Omaha, Neb.
NOBLE, JOHN A., Bloomington, Ill.
NORIEGA, JORGE A., Buenos Aires, Argentina
OLSEN, HARDY L., Redondo Beach, Calif.
PARHAROGLU, GEORGE H., Istanbul, Turkey
PARKER, CLAUDE Z., Los Angeles, Calif.
PARKER, KENTON L., JR., Glendale, Calif.
PAULETTA, CARL E., Wellsville, N. Y.
PLUMB, WILLIAM W., Atlanta, Ga.
PLUMMER, DIRK A., Greenwich, Conn.
PORTER, WILLIAM R., Willowdale, Ont., Can.
POWELL, ROBERT D., Norwood, Ohio
PREIS, HERMANN, Alliance, Ohio
PRILLAMAN, LUTHER A., Atlanta, Ga.
PRUESSMAN, WILL, Schenectady, N. Y.
RIEDEL, RALPH H., East Cleveland, Ohio
ROBBINS, BRUCE A., San Francisco, Calif.
ROCHE, WARREN F., Arlington, Mass.
ROTH, ELI B., Portsmouth, N. H.
RUBEY, ROBERT J., Philadelphia, Pa.
RUBY, GEORGE M., Des Moines, Iowa
RUNO, WILLIAM R., Clifton, N. J.
SANN, ROBERT I., New York, N. Y.
SAREEN, KRISHNA S., Manchester, England
SCHMITT, CHARLES R., Philadelphia, Pa.
SCHURMAN, GLENN A., La Habra, Calif.
SEPEHRI, IRAJ, Khoramshahr, Iran
SHANK, MAURICE E., Cambridge, Mass.
SHOEMAKER, ROBERT C., Portland, Ore.
SPROW, EARNEST A., Spokane, Wash.
STADIE, KLAUS B., Hamburg, Germany
SULLIVAN, WILLIAM F., Eastview, Ont., Can.
SUNDBY, BO GUSTAV, Berwyn, Ill.
SUTPHEN, PETER M., Charleston, W. Va.
TAMM, EMIL S., Morristown, N. J.
TANG, TOM, Philadelphia, Pa.
THOMSON, ROBERT E., Chatham, N. J.
TIPPETS, FRANK E., Richland, Wash.
TOOKE, THOMAS H., Springfield, Mass.
TUCKER, JESSE R., Portland, Ore.
ULLOCK, DONALD S., South Charleston, W. Va.
UNHOLTZ, KARL, New Haven, Conn.
VAFADARI, SHAHROKH, Teheran, Iran
VAN ACKER, JOSEPH E., Basking Ridge, N. J.
VAN DER HAMSVOORT, GODEFRIDUS C., Hamilton Ont., Can.
VANDER SLUYS, JOHN M., Clifton, N. J.
VANDER VOORT, GILBERT H., Graniteville, S. C.
WAGNER, RICHARD S. V., Olena, N. Y.
WALLICK, PAUL C., Alhambra, Calif.
WATSON, HOWARD H., Akron, Ohio
WELCH, G. LESLIE, Wheaton, Ill.
WELLS, JOHN R., New York, N. Y.
WERFELMANN, PAUL H., Arlington Heights, Ill.
WINNARD, WALTER H., JR., Anaheim, Calif.
WIXSON, DONALD F., Wellsville, N. Y.
YOUNG, WILLIAM E., East Pittsburgh, Pa.

Change in Grading

Transfers to Member or Affiliate

ALLEN, FRANK L., JR., Upper Montclair, N. J.
ANDRESEN, ROBERT L., Phoenix, Ariz.
BREED, ALLEN, North East, Erie, Pa.
CAMPBELL, SHERMAN B., Erie, Pa.
CHASE, GEORGE F. M., Racine, Wis.
DI MAGGIO, SAMUEL S., JR., Rochester, N. Y.
EARNHEART, BILLIE G., Texas City, Texas
EVANS, WALTER R., Falcon, Venezuela, S. A.
FARQUHARSON, KENNETH J., Norwalk, Conn.
FRANKEL, SAMUEL R., Reading, Pa.
GUNSELMAN, MERVIN D., Erie, Pa.
HEATH, DWIGHT P., St. Albans, W. Va.
LOCKE, DAVID W., Claymont, Del.
LONG, RALPH H., JR., Hyattsville, Md.
MILLER, CHARLES B., Long Beach, Calif.
MOORE, JOHN E., Baytown, Texas
O'BRIEN, PATRICK J., Rutland, Vt.
PRINCE, WILLIAM S., Washington, D. C.
SAPER, MARTIN L., Jackson, Mich.
SIGNORELLI, ALFRED A., New York, N. Y.
SPIELMAN, MAURICE, Haifa, Israel
SYBERT, WARREN M., Whittier, Calif.
TROUT, ROBERT G., Altadena, Calif.
VERLANDER, WALTER J., New Orleans, La.
WILCOX, WALTER M., Westminster, Mass.

Transfers from Student Member to Associate Member 270

Obituaries . . .

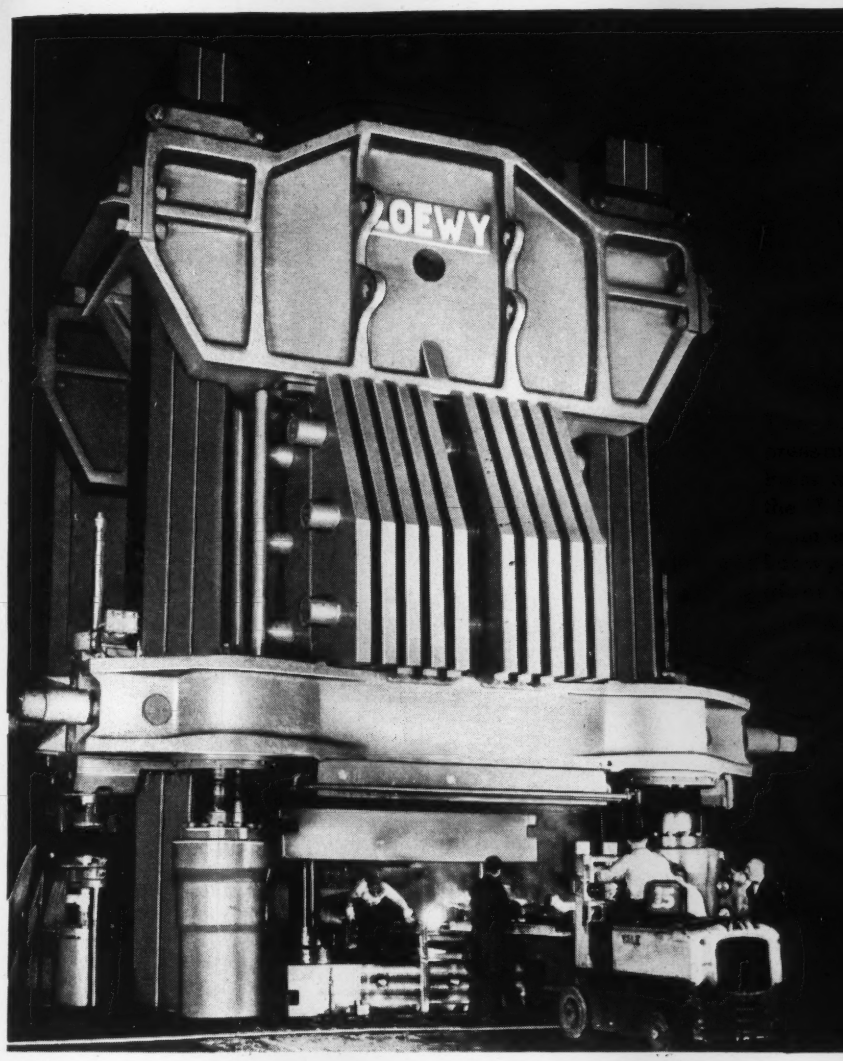
Claude Mitchell Barron (1886-1935), retired general purchasing agent, Consolidated Railroads of Cuba, died April 18, 1955, in St. Petersburg, Fla. Born, St. Louis, Mo., Feb. 8, 1886. Parents, Oliver B. and Sarah R. (Mitchell) Barron. Education, graduate, St. Louis Manual Training School; special courses covering railroad machinery and equipment. Married Emma Van Loan Towne, 1912; daughter, Doris (Mrs. Irving T. Klein). Jun. ASME, 1910; Assoc. Mem. ASME, 1914; Mem. ASME, 1935.

George Lothrop Dow (1897-1955?), whose death was reported recently to the Society, was senior engineer, Albert Kahn Associated Architects & Engineers, Inc., Detroit, Mich. Born, Detroit, Mich., Aug. 16, 1897. Parents, Alex and Vivia (Kinnersly) Dow. Education, graduate, Lawrenceville (N. J.) School. Married Virginia Jones, 1933. Married 2nd, Othal Dimmett, 1940. Mem. ASME, 1944.

Joseph Marchand Hall (1887-1955?), retired mechanical engineer, Cardwell Westinghouse Co., Chicago, Ill., died recently at his home in Rolling Hills, Calif., according to a report received by the Society. Born, Howard, S. Dak., Feb. 25, 1887. Parents, William A. and Challie R. Hall. Education, graduate, high school; South Dakota State College, Brookings, S. Dak. Married Vesta Blanchard; children Marchand B., Reinette, Betty Kay. Mem. ASME, 1933.

Harry Arthur Stevens Howarth (1877-1955), pioneer in the science of lubrication and senior research engineer, The Franklin Institute's Laboratories of Research and Development, Philadelphia, Pa., died April 21, 1955, at Dufur

(ASME News continued on page 656)



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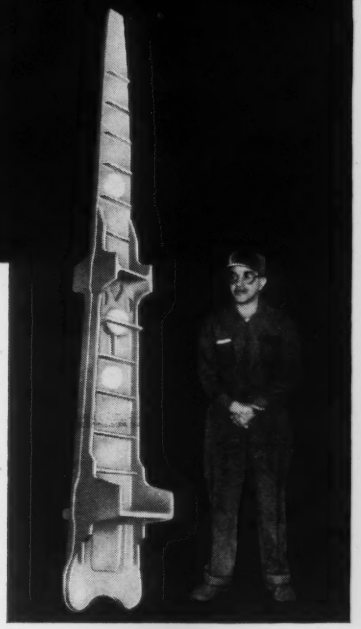

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Hospital, Ambler, Pa. Born, New Haven, Conn., Feb. 13, 1877. Parents, James A. and Lillian F. (Stevens) Howarth. Education, PhB, Sheffield Scientific School, Yale University, 1899. Married Blanche D. Freeman, 1903, divorced, 1911; daughters, De Weese (deceased), Miriam (Mrs. J. G. Jackson). Married 2nd, Effie Marie Sloan, 1915, died 1936. Married 3rd, Mary Johnston; daughter, Holley. He was a professor of mechanical engineering at Lehigh University and later professor of machine design, Carnegie Institute of Technology. Author of numerous technical papers on bearings and lubrication and a major contributor to "Kent's Mechanical Engineers' Handbook." Mem. ASME, 1908. He served the Society for several years on the Lubrication Research Committee. In 1936 the Society awarded him the Melville Gold Medal. In 1914 his long association began with Albert Kingsbury, who was then developing his pivoted-pad thrust bearing. During this association he was responsible for many of the major developments in oil-film bearings and was awarded patents on more than 15 inventions in the field. Later, he founded the Howarth Pivoted Bearings Co. in Philadelphia. A bearings consultant and designer for the Bureau of Ships during World War II, he was concerned with problems such as oil-film, thrust, and engine-crankshaft bearings. In 1946 he became associated with The Franklin Institute as a research engineer where he was in charge of the design of various major components of ordnance gun mounts and carriages, and served as consultant on all bearing problems. He was a member of Sigma Xi and a fellow of the American Association for the Advancement of Science. Survived by wife; two daughters, Mrs. Joseph G. Jackson and Holley; and a brother, James A. Howarth, Jr., Shelton, Wash.

John Bartleman Klumpp (1873-1955), consulting engineer of Philadelphia, Pa., and one of the country's outstanding gas engineers, died March 29, 1955. Born, Jersey City, N. J., June 2, 1873. Parents, John F. and Ellen (Bartleman) Klumpp. Education, ME, Stevens Institute of Technology, 1894; hon. DE, 1944. Married Theodora E. Meyer, 1896. He had been employed by The United Gas Improvement Co. for 35 years; at the time of his resignation in 1929 he was vice-president. Prior to and since becoming a private consulting engineer, he served as a gas and electric consulting expert for the National Civic Federation; as a witness on gas standards and rates before many state public-utility commissions, and with the U. S. Bureau of Standards; and as a consultant for the Counsel of National Defense during World War I in connection with the production of toluol. In 1930 he was appointed consulting engineer to the Municipal Gas Commission of Philadelphia, in connection with the operation of the Philadelphia Gas Works. Included also in his activities were his assignement as consultant for the Minister of Development in the cabinet of the President of Venezuela; employment by many large utility, industrial, steel, and insurance companies on special reports. More recently, he had been designing and installing water-purification systems for municipal and private companies. Mem. ASME, 1909. He was a member of the British Institution of Gas Engineers; Fellow AIEE; and past-president of the American Gas Association. Survived by wife and a sister, Mrs. George A. McIlroy, Jersey City, N. J.

Norman I. Price (1877-1954), electrical engineer, Price Martyn & Co., Sydney, New South Wales, Australia, died Oct. 4, 1954. Born, Auckland, New Zealand, Jan. 18, 1877. Education, Auckland College; New Zealand University; Birmingham (England) Technical College; and special courses at Cornell University. Jun. ASME, 1902; Mem. ASME, 1921. He was a member of the Old Guard and had been awarded the ASME 50-Year Medal. An engineer of international training and experience, he was well known in Kalgoorlie and Broken Hill, and in the Queensland sugar-milling area. Survived by wife, Florence Price.

William Alva Roberts (1897-1955), president, Allis-Chalmers Manufacturing Co., Milwaukee, Wis., since February, 1951, died April 12, 1955. Born, Osceola, Mo., Aug. 25, 1897. Parents, Charles W. and Valeria A. (Embry) Roberts. Education, attended Springfield (Mo.) Business College, 1915. Married Alma Embrey, 1919. Affiliate ASME, 1954. In 1952 he received the American Schools and Colleges Association's Horatio Alger Award. In 1954 President Eisenhower appointed him a member of a special five-man advisory committee on a national highway program. He had an active interest in several industrial, charitable, and civic groups. Survived by wife, his parents, three sisters, and four brothers.

Ernest L. Root (1887-1954), district manager, The Permutit Co., Boston, Mass., died Sept. 10, 1954. Born, Omro, Wis., May 28, 1887. Parents, Calvin B. and Etta Root. Education, high-school graduate; special courses in engineering at night schools and correspondence schools. Married Laura J. Hufmeyer, 1913. Mem. ASME, 1929. He served the Society on the Executive Committee, Boston Section.

Keep Your ASME Records Up to Date

ASME Secretary's office in New York depends on a master membership file to maintain contact with individual members. This file is referred to dozens of times every day as a source of information important to the Society and to the members involved. All other Society records and files are kept up to date by incorporating in them changes made in the master file.

From the master file are made the lists of members registered in the Professional Divisions. Many Divisions issue newsletters, notices of meetings, and other materials of specific interest to persons registered in these Divisions. If you wish to receive such information, you should be registered in the Divisions (no more than three) in which you are interested. Your membership card bears key letters opposite your address which indicate the Divisions in which you are registered. Consult the form on this page for the meaning of the letters. If you wish to change the Divisions in which you are registered, please notify the Secretary's office.

It is important to you and to the Society to be sure that your latest mailing address, business connection, and Professional Divisions enrollment are correct. Please check whether you wish mail sent to home or office address.

For your convenience a form for reporting this information is printed on this page. Please use it to keep the master file up to date.

ASME Master-File Information

(Not for use of student members)

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Publication	*Address changes effective when received prior to:*
☐ MECHANICAL ENGINEERING	10th of preceding month
☐ Transactions of the ASME	20th of preceding month
☐ *Journal of Applied Mechanics*	20th of preceding month
☐ *Applied Mechanics Reviews*	1st of preceding month

Please register me in three Professional Divisions as checked:

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☐ B—Applied Mechanics
☐ C—Management
☐ D—Materials Handling
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☐ H—Hydraulics
☐ J—Metals Engineering
☐ K—Heat Transfer
☐ L—Process Industries
☐ M—Production Engineering
☐ N—Machine Design
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